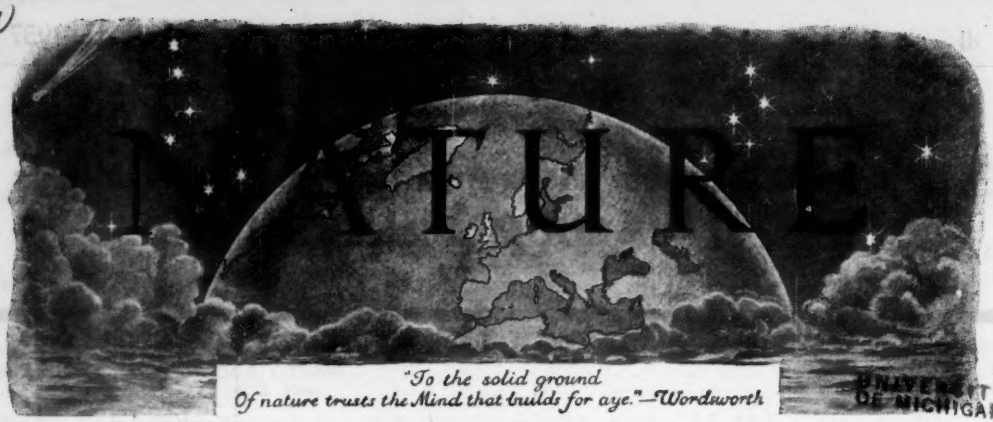

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VOL. 179, No. 4567 SATURDAY, MAY 11, 1957

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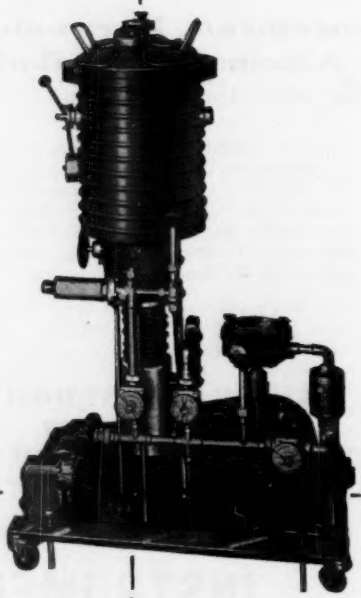

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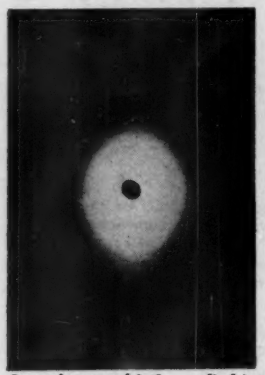
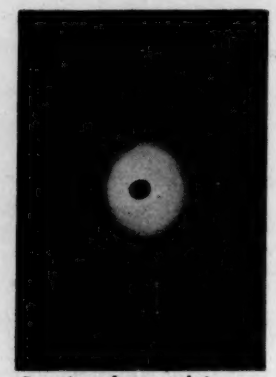


Laue photograph in 6cm. cylindrical camera. Radiation: Cu, white. Exp: 40 hrs. at 40kV, 15mA



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SCIENCE AND GOVERNMENT

WHEN on April 11 Mr. D. L. Donnelly asked the Prime Minister whether he would recommend the appointment of a Select Committee to review and inquire into the working of the present system of government in Britain with the view of reducing the burden on Ministers and securing the more efficient working of Parliament, Mr. Harold Macmillan replied that he intended to give the idea behind the suggestion further consideration. Mr. Macmillan added that very large questions were raised as to the functions of Ministers and their duties to Parliament and the great increase in work with the complexity of modern government. Mr. Emrys Hughes suggested that a committee system rather than a Cabinet system might decrease the burden on Ministers; but Mr. Macmillan pointed out that before the system of collective responsibility of the Cabinet could be abandoned, a certain amount of study would be required. He indicated that he proposed to consult experienced Ministers and ex-Ministers on both sides of the House who, from a detached position and because of their long service, might be able to offer suggestions to make the work easier and, to that extent, more fruitful.

One name immediately suggested in this connexion was Lord Salisbury; but it is precisely in respect of the office of the Lord President of the Council, lately held by Lord Salisbury, that increasing concern has been expressed in recent years, particularly in regard to the co-ordination of the scientific and technical effort of Britain. In a recent party political broadcast, Lord Brand attributed the rapid increase in general well-being in Britain not to any great extent to the Welfare State or to legislation, but to the altogether exceptional advance in scientific knowledge, technology and invention in the past generation or two. When challenged as claiming too much, he maintained that it is self-evident that science, invention and technology are much the most important elements in increased material welfare. Without such advances it is true that nothing that governments themselves could have done would have raised the standard of living to anything like the same extent; but none the less, the way in which government is organized, and especially the means for relating knowledge and action, are important factors, and there is evidence that the present arrangements are neither so effective nor so efficient as they might be.

Lord Salisbury's recent resignation in itself prompts fresh examination of the position which the Lord President's office occupies in that respect; and the Prime Minister's assumption, under an Order in Council, of the functions formerly exercised by the Lord President of the Council in relation to nuclear energy, taken with his reply on April 11 already noted, suggests that Mr. Macmillan may be now sufficiently in touch with one aspect to have personal experience of its importance. He is to be assisted in the discharge of these functions by the Paymaster-General; but even with such assistance, doubts will remain as to how far they can be efficiently discharged by the Prime Minister in addition to his other responsibilities as head of the Government.

That Cabinet Ministers are grossly overworked is undeniable; but that is only one of the reasons why the position of the Lord President of the Council has been regarded with some concern in recent years. The debates on the Department of Scientific and Industrial Research Bill last year, and the earlier debates on the Atomic Energy Authority Bill which led to the Lord President of the Council being made responsible for the Atomic Energy Authority, indicated a growing concern with the organization of Britain's effort in scientific and industrial research, and also with the distribution of scientific and technical man-power. Moreover, the piecemeal approach to scientific and technical matters, in which the present Government and its predecessors have persisted, has steadily undermined the confidence of the scientific community about the competence and sincerity of the Government in such matters.

Such a position is fatal to the co-operation and understanding required both in the giving and use of scientific and technical advice. If the scientist is to co-operate, the Government must inspire his respect. This is not to say that the proper application of science to the needs of the nation can be determined by scientists alone; rather, the best scientific advice will not be available unless due regard is had to the conditions under which such advice can be secured and made effective.

With the increasing complexity of modern government and the extent to which scientific and technical factors enter into public affairs, this question of scientific and technical advice has assumed an importance paralleled only by defence, which is of course a field where it is now of prime importance. Indeed, it may well be that there is something to be learned from the Services in this matter which could help to establish the appropriate system. Nearly forty years ago, a committee under Lord Haldane reported on this question of how Ministers were to be enabled to keep abreast of departmental matters and the issues that must come to Cabinet-level, and still find time for such forward thinking about policy that they are not caught unprepared by sudden crises. Little came, however, from the Machinery of Government Report; but in the field of defence there has been thrown up a system designed to meet a very similar position.

Sir John Slessor made some suggestive comments on this system in his recent book "The Central Blue: Recollections and Reflections"*. Sir John, who has had extensive experience of the Chiefs of Staff Committee, vigorously refutes the attempt to condemn

* The Central Blue: Recollections and Reflections. By Sir John Slessor. Pp. xiv+709. (Cassell and Co., Ltd., 1956.) 30s. net.

the system as "making war by committee". On the contrary, thirty years experience leads him to believe that the system as developed and matured during that period is about as good a method as could be devised for the higher direction of defence policy in Britain. His analysis is of interest in connexion with the organization, if not the direction, of the scientific effort of Britain at the present time for two reasons. He recognizes that the British people, by temperament and experience, may well be better at working in committee than other peoples, and he enunciates some principles which are as sound in the working of a system of control in science as in defence; and further, but in the same context, he makes at least one suggestion which seems to bear on the particular position of the Lord President.

In the Chiefs-of-Staff system described by Sir John, the three Chiefs of Staff are collectively responsible for offering military advice to the Cabinet while at the same time, as individuals, they are the professional heads of their Services, responsible for their fighting efficiency and the direction of their operations in war. In that is implicit the golden rule that is the *sine qua non* of any sound system, whether it be for the direction of defence, the development of nuclear energy, or any other comparable field, that the man who gives the advice to the Cabinet must be the same man who has the ultimate responsibility for putting it into effect. Neglect of this principle, which nevertheless was stressed in the White Paper outlining the Central Organization for Defence more than ten years ago, is largely responsible for the shortcomings in the application of science and technology in national affairs.

To take first, however, the question of science and defence: the Defence Research Policy Committee was set up ten years ago to facilitate the continued and complete integration of military and scientific thought at all levels, and to ensure that in planning defence research as a whole, account is taken of the scientific effort of the country in other fields in order that resources may be efficiently and economically used. The Committee itself consists of those responsible, both from the operational and scientific angles, for research and development in the Service Departments and the Ministry of Supply, and its chairman has also been the chairman of the Advisory Council on Scientific Policy. It has been responsible for advising, on operational questions, the Chiefs of Staff and, on wider aspects, the Defence Committee and the Minister of Defence.

Neither its functions nor its personnel thus conform entirely to the principle laid down by Sir John Slessor, particularly with the increasing complexity of modern weapons and the extent to which the whole field of production is interwoven with the civil economy. Here indeed there is apparent the importance and value both of the suggestion he makes for the inclusion in the Chiefs-of-Staff system of a chief staff officer to the Minister of Defence, as was introduced during the War in the person of General Ismay, and of the principle of the predominant partner. This staff officer is a carefully chosen man with the right background of experience, and Sir John points out that he can make all the difference to the value of the committee, particularly by facilitating the reaching of decisions, both in committee and by tactful discussion behind the scenes.

Sir John Slessor's clear recognition that there are other factors than the Service point of view that may determine decisions even in matters of defence gives the greater point to an argument which is by no means new. Both Sir John Anderson (as he then was) in his Romanes Lecture in 1946, and Mr. H. R. G. Greaves in his "The Civil Service in the Changing State" (1947), examined the Chief of Staffs system and the defence organization and discussed its application to, at any rate, economic affairs; but Sir John brings out a little more clearly the value of this idea of a chief staff officer in developing an impartial, inter-departmental outlook, initiating action on aspects of a problem overlapping or falling between departments, and suggesting methods of reconciling conflicting points of view. Such functions are particularly needed in the scientific field, for scientific developments are not confined to departments; further, as Sir Henry Tizard has rather trenchantly remarked, scientists are not given to compromise, and a committee consisting solely of scientists is likely to be an ineffective instrument of policy. Any device that assists them to work sufficiently close together is to the public advantage, and if the central scientific staff, engaged only in studying questions of policy, under the immediate direction of the Advisory Council on Scientific Policy, which Sir Henry suggested in his Haldane Memorial Lecture, did no more than throw up scientific administrators of this calibre, it would be well worth while.

The principle of the predominant partner, according to which in joint operations the command of such an operation is entrusted to a commander from the Service which has the major interest in the operation, though only in the sense of co-ordinator or chairman, has also something which bears on the utilization of science by government, neglect of which in matters like nuclear power, transport, fuel, water supply, and the like could easily have serious consequences to the national economy. The belief, rightly or wrongly, that, even when the scientific aspect represents the predominant factor in determining policy in a particular problem, science is not given due weight, is largely responsible for dissatisfaction with the present system, in which ministerial responsibility for the formulation and execution of the Government scientific policy is vested in the Lord President of the Council. The other ministerial responsibilities which the Lord President has carried and the absence of an adequate staff in his office have added weight to this conviction.

Mr. H. R. G. Greaves's analysis did not touch specifically on the problem of science as such in Government, though the stress he places on flexibility and on the need for an informed public, with, as corollary, a deliberate effort to inform the public, with channels of information providing an adequate

flow upward as well as downward, is highly pertinent. He does not, however, carry it, as did Sir Henry Tizard, to the point of displaying the bearing of education on this gap. To close the gap and to remove the present lack of understanding, by ensuring that far more administrators have had a scientific education and that there is a much wider public comprehension of the nature and limits of scientific effort, are fundamental contributions to the more effective use of scientific knowledge in public affairs and the wise use of our resources. If the Lord President is in any sense, however informal, a Minister of Science, that is one sphere in which his influence should be direct and decisive.

The improvement of public education in this way bears powerfully on this question of relieving the burden on Cabinet Ministers for another reason. "Everything depends, in administration and in high politics, upon the extent to which those who govern, and those who are governed, are able, to some extent at any rate, to put themselves in each other's places." That remark of Mr. Joseph Chamberlain at Bloemfontein in 1903 is manifestly largely untrue in the scientific field, and because of it there is danger that too rigid an organization may be developed; rigidity would handicap both scientific work itself and the communication and application of its responsibilities in government and the public service. Even an American observer, Prof. S. H. Beer, has recently remarked that no formal arrangement of committees and staffs could quite free British government of its dependence for co-ordination upon the common rooms and lunch tables of the clubs of Pall Mall, nor would any unifying set of directives take the place of the strong corporate life of the higher Civil Service in Britain. One of the important reasons for seeing that the scientist and technologist receive a broadly based education is to enable them to take part on equal terms in such discussions with men from other walks in life.

Lord Waverley, in the Romanes Lecture already noted, expressed strongly the view that the general model of the Chiefs-of-Staff system might be followed with great advantage in relation to scientific services, though he did not advocate the organization of a Joint Scientific Staff; he suggested instead that a section of the Cabinet Secretariat might be organized to assist the Lord President as the Minister responsible for the general aspects of scientific investigation, and that thereby provision would be made without prejudice to the work of departmental scientific staffs for enlisting scientific advice on the highest level for the guidance of Ministers. In this Lecture Lord Waverley was advocating a system of Cabinet committees, such as Mr. Macmillan may now be presumed to be examining; but although Lord Waverley then emphasized the importance of securing flexibility in any such system, and stressed the practical importance of adequate provision to make collective responsibility real, he forbore to discuss further the provision of scientific advice on the ground that the whole matter was under consideration by a government committee.

No such report has been forthcoming in the past decade, and it appears that no publication of any such report is contemplated. The Prime Minister's reply, however, gives fresh interest to Prof. K. S. Wheare's essay on the British Constitution entitled "Government by Committee"* published two years ago. Prof. Wheare discussed the functioning of six different types of committee; but although he brings out some sound points about the relation between layman and expert and the functions of a chairman, it is his two chapters on committees to inquire and committees to advise which are most relevant both to this problem of the organization of science in relation to government and to that of lightening the work of Cabinet ministers. The chapter in which he discusses the functions of a committee in the conduct of administration is almost entirely concerned with local government.

Prof. Wheare notes that the work of some departments requires that their scientific and technical experts should be more than advisers to officials and should undertake administration themselves, much of which could not be carried out unless the administrator had a specialized knowledge of the fields with which they deal. Again, in discussing the qualities of a good layman in committee work, he points out that a good layman ought to be knowledgeable—not necessarily an expert on the matter with which the committee is concerned, but preferably an expert in something relevant; thus he supports all that Sir Henry Tizard and Mr. Walter Elliot have said as to the importance of a broadly based education. The scientist, no less than the administrator, needs an education which develops not simply a questioning and critical temper but also common sense and balance.

So far as membership of committees is concerned, Prof. Wheare considers the place for the expert is upon committees to advise, and that for the layman upon those to legislate, to administer, and to scrutinize and control; but he promptly concedes that there is a place for laymen upon committees which advise and for independent experts upon committees which negotiate. He emphasizes the supreme importance of wise leadership if the best is to be made out of committees; and if government by committee is to ensure that the best use is made both of democracy and of bureaucracy, the system of education in Britain must be such as to throw up an unfailing succession of chairmen and officials able to fulfil their vital and difficult roles with skill and success in a world in which science and technology are increasingly important.

We are thus brought back once more to the primary importance of the system of higher education. Whatever improvements can be devised in the organization of the system of government in Britain and in the provision made for advice on scientific and technical problems in public affairs, the application of scientific and technical knowledge in defence or in civil affairs, or the continuous scientific study of such matters, the

* Government by Committee: an Essay on the British Constitution. By K. C. Wheare. Pp. vii+264. (Oxford: Clarendon Press; London: Oxford University Press, 1955.) 25s. net.

effectiveness of any organization depends ultimately on the men who use it. A rigid system of organization may easily defeat its own object and hinder scientific and technical advance; whereas with flexibility and clear mutual understanding on the part of the Minister and official or administrator, the scientist and the technologist, it may well be possible to achieve the wisest and most effective deployment of resources in materials and man-power with much less strain on Ministers and a minimum of formal organization. It is to be hoped that the examination the Prime Minister is now conducting will pay particular attention to the Lord President's office and its staffing, and to this whole question of the organization of the scientific and technical effort of Britain, in relation to the communication of scientific and technical knowledge and advice, its continuous acquisition and the training and deployment of scientific and technical man-power. The results of that section at least of his inquiry should be made available for informed discussion; meanwhile, the Parliamentary and Scientific Committee and some of the learned and professional societies associated with it could well examine some of the issues which were brought to light in the debates on the Department of Scientific and Industrial Research Bill, the importance of which has been emphasized since in connexion with nuclear energy and other matters.

THE HISTORY OF THE MICROSCOPE

Microscopium

By Maria Rooseboom. Pp. 60. (Communication No. 95 from the National Museum for the History of Science, Leiden, Holland.) (Leiden: National Museum for the History of Science, 1956.) n.p.

THIS is, in effect, a brief history of the chief development of the optical microscope, from Robert Hooke and Leeuwenhoek to the phase-contrast instrument for which Prof. Zernike received the Nobel Prize in 1953. It is particularly notable for the superb full-page illustrations, of which a number are in colour. As the size of the page is roughly 12 in. × 8 in. and the reproduction excellent they repay careful study. The instruments represented are mostly in the Dutch National Museum for the History of Science at Leyden and it is flattering to our national pride that so many of them should be of English origin, as is also the fact that the book appears in English and is adorned with well-chosen quotations from early English writers.

These quotations give rise to a little riddle. The book begins and ends with an extract from a poem "In Commendation of the Microscope" by Henry Power, dated 1661. Now the only printed book by Henry Power is his "Experimental Philosophy in Three Books", 1664, the first book of which deals with microscopical observations, but does not contain the poem, which, so far as I know, existed only in the Sloane MS. at the beginning of this century, although it may have been printed since. The author gives no indication of the source of the poem, but shows the extracts in what would appear to be facsimile reproduction of seventeenth-century printing. I suspect an amiable mystification. Again, if it is not ungracious to raise trifling criticism of what is in so many ways a delightful book, the text is introduced by an English passage, in quotation marks, followed by "With these words Pierre Borel . . .". But Borel's book was in Latin. The serious student, whom there is so much to please in this work, would have appreciated references, which are everywhere lacking, to indicate the sources of the various interesting and apposite citations.

The text is in the nature of illuminating notes concerning the development of various parts and functions of the microscope. For example, one section deals with the evolution of the modern apochromatic objective from the little-known achromatic design of Beeldsnijder, of about 1791, to modern times, illustrated with excellent pictorial diagrams; another section deals with methods of illumination, often neglected; other sections with focusing and with the movement of the stage. One interesting page shows, in silhouette, the pattern of selected typical microscopes from 1800 to 1900. The binocular microscope, from Cherubin d'Orleans to Zeiss–Winkel of 1954, also has its couple of informative pages, with a colour plate of the R. and J. Beck instrument of 1875.

To be effective, a brief survey of this kind demands wide knowledge, good taste, fine drawing, excellent technique of reproduction and considerable financial support. The National Museum for the History of Science at Leyden is to be congratulated that all these have been forthcoming to help in the production of the elegant record before us.

E. N. da C. Andrade

TECHNICAL APPLICATIONS OF RADIOACTIVITY

Die Technischen Anwendungen der Radioaktivität

Von Dr. Engelbert Broda und Dr. Thomas Schönfeld. Pp. x+313. (Berlin: Veb Verlag Technik; München: Porta-Verlag, 1956.) 19 D.M.

BRODA AND SCHÖNFELD have written a most valuable book. It is the first of its kind in which the technical applications of radioactivity are complete with many hundreds of references, and the discussion of the whole subject is done extremely well. There are thirteen main chapters. After the introduction comes a very well-written chapter on the fundamentals of radioactivity which includes discussions on such subjects as ions, molecules, isotopes, fission, radiations and their absorption and radiochemical equilibrium. The third chapter deals with the measurements of radioactivity, giving a very concise picture of counting techniques. The next chapter deals with the production and chemical purification of radioisotopes. This chapter is very short but gives in ten pages all the relevant facts. Chapter 5 deals with isotopes used as indicators and gives details of the rare occasions where the emanation method can be used.

The next six chapters form the main part of the book (comprising 220 pages) and deal with the application of radioactivity or the radiation of radioisotopes in different fields. This is extremely well organized according to subjects and should be of equal interest to the chemist or to any scientist working in a research laboratory, irrespective of the subject he is dealing with.

The use of radioisotopes in chemical analysis is dealt with in great detail. For example, the chapter on "Activation Analysis" gives in eighteen pages every detail of this application, which is becoming more and more of general interest. Other chapters deal with radioactivity in mining and the metal and heavy industries and the application in the chemical industry. Special applications are mentioned in the rubber, plastic, textile and pharmaceutical industries. Applications in agriculture, genetic effects of radiation and many other interesting uses of radioactivity are described. The descriptions generally are accurate and concise, and a great effort has been made to bring out the essentials. The authors should be congratulated that they have succeeded so well in doing this.

One chapter deals with isotopes in process control, such as thickness gauges, etc.; and Chapter 12, occupying some 75 pages, is devoted to the application of radioactive rays on materials. The production of sources for high ionizing radiations is mentioned, and the application of these radiations, which is perhaps the latest and newest chapter in "Isotopery", is covered fully up to 1956. The last short chapter summarizes the health precautions necessary when working with radioactive materials.

A great effort has been made throughout to give a complete picture in each field by quoting all relevant references. The authors have benefited a lot from the papers given at the Geneva Conference, which are frequently referred to in this book. It is especially gratifying to see for once a scientific book which is really international in its outlook and references. All too often, especially in the American literature, in books and articles covering certain fields, one finds that only the national literature is referred to. The quality of production is not outstanding; the print, for example, is rather small and there are no illustrations and very few diagrams. This is most likely intentional in order to keep the price of the book reasonable.

It is only to be hoped that this very useful and well-balanced book, which gives a precise summary of all radioactive applications, will be translated into other languages so that it can be made available to scientists all over the world.

HENRY SELIGMAN

POLIOMYELITIS

Management of Life-Threatening Poliomyelitis, Copenhagen, 1952–1956

With a Survey of Autopsy Findings in 115 Cases. Edited by Prof. H. C. A. Lassen. Pp. xi+180. (Edinburgh and London: E. and S. Livingstone, London, Ltd., 1956.) 22*s*. 6*d*. net.

Handbook on Poliomyelitis

By Dr. Joseph Trueta, A. B. Kinnier Wilson and Margaret Agerholm. Pp. vii+139. (Oxford: Blackwell Scientific Publications, 1956.) 20*s*. net.

IN 1952 Denmark sustained an epidemic of poliomyelitis in which the attack rate was higher and the disease more severe than that country had ever previously known. Among other cases there were 345 patients with more or less severe respiratory disability for whom the available supply of conventional respirators (tanks and cuirasses) was utterly inadequate. The method of treatment improvized in this emergency not only saved many lives at the time but also paved the way for further technical advances. High tracheotomy was performed, a cuffed tracheotomy tube being used for preventing pharyngeal secretions from reaching the lungs, and intermittent positive pressure respiration was applied manually from an anæsthetic bag via the tracheotomy. Efforts were made to keep the lungs dry by intensive physiotherapy and aspiration.

"Management of Life-Threatening Poliomyelitis" is devoted mainly to a description of the clinical state, investigation and treatment of these respiratory cases. An initial difficulty is that the classification of patients is partly clinical and partly anatomical and is wholly confusing, at least to me. This is regrettable as so much of the book is well worth reading. The chapters on "The Anæsthetist and Artificial Ventilation", on lung physiotherapy and on de-cannulation and the complications of tracheotomy are particularly good. There is a short but interesting account of renal calculus formation and artificial ventilation, and the various investigations which were carried out are fully discussed. One criticism is that, having initiated a form of treatment of great value in certain circumstances, these workers have failed to accept its limitations in other circumstances. Too little regard is paid to the lessons learnt since 1952 and this diminishes the value of an otherwise excellent book.

The aim of Prof. J. Trueta and his co-authors is to give a concise account of the main problems related to poliomyelitis and in this they have been entirely successful. This is a straightforward and readable book which could profitably be read by anyone interested in the subject. These authors also discuss fully the treatment of patients with respiratory disability and their outlook is surprisingly different from that of the Danish writers. It is more in accord with that of most British clinicians to-day, although probably few would agree that "the cabinet type of respirator is the only satisfactory one in the acute stage" (p. 64). Most of them would agree that tracheotomy should not be undertaken lightly, but may be unavoidable for a patient with both respiratory and swallowing weakness and that, in such circumstances, positive-pressure breathing may be indicated. The sections on management in the later stages of the illness are balanced and informative and the clinical descriptions are very good. It is a disadvantage that there is no list of contents and too many misprints have escaped detection, but these are details which can be corrected if, as seems likely, further editions are needed.

T. GEFFEN

BACTERIAL MAP MAKING

Bacterial Anatomy

Sixth Symposium of the Society for General Microbiology, held at the Royal Institution, London, April 1956. Edited by E. T. C. Spooner and B. A. D. Stocker. Pp. viii+360+23 plates. (Cambridge: At the University Press, 1956. Published for the Society for General Microbiology.) 30*s*. net.

IT is not many years since the bacterium was considered to be made up wholly of nuclear material and only the outside or capsule had much interest for bacteriologists and immunologists. Nowadays the bacterial cell is studied by almost anyone

who can handle a microscope, optical or electronic, and a camera, and the list of contributors shows that biochemists, cytologists, geneticists and physicists contribute more than bacteriologists to this symposium. The symposium itself was notable for the attacks made by Drs. Bisset and Robinow on Dr. DeLamater, who holds that mitosis occurs in division of the bacterial nucleus; the papers published in this book (which were taken as read at the meeting) show how irreconcilable the views of these workers have become.

There were fewer dialectics and more progress was reported in the study of other parts of the bacterial cell. Salton has contributed much to our knowledge of the chemistry of the cell wall, which varies not only between Gram-positive and Gram-negative bacteria, but also between different genera within these major groups. The cell wall, made up of amino-acids, amino-sugars and lipids, forms a rigid skeleton of the intact cell; without it the cell (protoplast) assumes a spherical shape. Lysozyme has proved an effective agent in removing the cell wall of susceptible strains without damaging the underlying structure, and the studies of Weibul and McQuillan have added a great deal to what is known about the protoplast. Protoplasts derived from flagellated cells retain the flagella but are non-motile; presumably the absence of a cell wall deprives the flagella of fixed points on which thrust can be exerted. Multiplication of protoplasts has not yet been shown conclusively but the development of pear-shaped protoplasts suggests that this may occur.

The symposium papers unfortunately perpetuate Tomcsik's error in distinguishing a strain of *Bacillus megaterium*, referred to as *Bacillus M*, from other strains of the species. This strain does not merit the particular attention it received in the symposium or elsewhere.

S. T. Cowan

THE ECHINODERMATA

The Invertebrates

By Libbie Henrietta Hyman. Vol. 4: Echinodermata, The Coelomate Bilateria. (McGraw-Hill Publications in the Zoological Sciences.) Pp. vii+763. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 75*s*.

THE Echinodermata, a large and important invertebrate phylum, has always stimulated the interest and attention of every kind of investigator. The amateur naturalist is attracted by the beauty and variety of its members and by their suitability for dried preservation. The general zoologist finds in them uniqueness of structure demanding probing of their origins and relationships. The physiologist studies their peculiar reactions, based on an apparently primitive nervous system, coupled with a lack of osmotic regulation. The ecologist works in a restricted field, since echinoderms, although world-wide in distribution, are exclusively marine. The embryologist explores the clues provided during their development that may link them with the great chordate phylum, and the palæontologist has at his disposal one of the most extensive fossil ranges in the whole animal kingdom. From all this work it might be thought that here is a phylum the study of which will produce results, yet Miss L. H. Hyman's conclusion, after all the labour she has put into the production of her volume, is: "I here salute the echinoderms as a noble group especially designed to puzzle the zoologist".

The plan of the book is much the same as in previous volumes. The author deals with the structure, physiology, development, classification, habits and behaviour, geographical distribution, parasites and fossil history of the five classes of echinoderms possessing living representatives, and with what is known, in a shorter form, of the five wholly extinct classes. Much of the book consists of abstracts of the very numerous papers that have been written by specialists. This makes the book valuable to the lecturer for its comprehensiveness, but difficult for the student to grasp, especially as the latter may be misled by lack of correlation between papers quoted. Thus on p. 553 it is implied that *Psammechinus miliaris* is an algal feeder (Milligan, 1916), but on p. 554 Eichelbaum (1910) is quoted as saying that it is mainly carnivorous, which Milligan confirms.

The author apologizes for including geographical distribution and wonders whether it will be "worth to readers the labor it cost and the space it occupies". On the contrary, this makes the book more acceptable to readers in the Old World, for they will find species living in the coastal waters of their own countries set alongside the New World species which the author almost invariably uses for her illustrations. Moreover, the convergence in form and habitat is striking, as anyone who compares the littoral inhabitants of both areas knows. Compare, to take one example, *Patiria miniata* (p. 345) from California with our own *Asterina gibbosa*.

The illustrations are partly collected from original works, while many have been drawn by the author. In the former group some of the blocks are worn, for example, *Stichopus*, p. 179; in the latter most are good and very clear, but a few, for example, *Psolus*, p. 127, are poor. Magnifications have been omitted, the author considering them "of no consequence". This is debatable, especially when similar structures are magnified to different degrees on the same page, as has been done with pedicellariae on p. 414.

The literature quoted is immense. Unfortunately, spelling errors have escaped the proof reader, such as Elmhurst (pp. 588, 734), Seelinger (pp. 75, 716), Colman (p. 176), and such names as Malgrenia (p. 585), brachiolara (p. 301) and Pelamatozoa (p. 700).

There is a concluding chapter dealing with problems posed by the phylum. It is interesting that not only does embryology lead us to link the ophiuroids with the echinoids and the asteroids with the holothurians, but physiologically the sterols of these classes belong respectively to Type 1 (cholesterol, etc.) and Type 2 (stellasterol, etc.). The palæontologists, however, link asteroids and ophiuroids in one class, Stellasteroidea, which is incompatible with modern evidence. The crinoids stand apart. Semon's dipleurula theory, taken up by Bather, is not of much use in determining the origin of the phylum, although there is no doubt that bilateral symmetry preceded radial symmetry in their evolution. But why *five* rays? To call the primitive form a pentactula is merely to add another hypothesis to mitigate but not explain our ignorance.

The book is excellently produced and there is a good index. May we in return salute Miss Hyman for the untiring energy, wide knowledge and clear judgment she has displayed in the preparation of this her fourth volume on the invertebrates.

N. B. Eales

Atlas of Representative Cometary Spectra

By P. Swings and L. Haser. Pp. 37+23 plates. (Liège: Astrophysical Institute, The University.)

THE spectra of comets present many problems of interpretation which are of interest not merely to astrophysicists but also to workers in several related fields. Few comets that have appeared since the advent of modern stellar spectrographs have, however, become bright enough to allow the collection of as many spectrograms as one would wish; and few reproductions even of those that do exist have been published. The appearance of this compilation will therefore be welcomed by astronomers, spectroscopists and physicists alike. It consists of 23 plates, each 12 in. by 16 in., chosen to illustrate as many aspects as possible of representative cometary spectra and related laboratory spectra. An effort has been made to include spectra of many different comets (for each displays its own individuality as well as exhibiting features common to all) secured on different telescopes and dispersions and at different heliocentric distances. The reproductions are, in fact, a selection of the best cometary spectrograms ever obtained anywhere. Though the authors disclaim any intention of providing a general exposé on cometary physics, their introductory text of 28 pages is in fact a useful summary of present knowledge of the subject. In this they first discuss the spectra of various parts of the typical comet; go on to compare these with the spectra of auroræ, the airglow and various combustion phenomena; and finally list important data concerning laboratory spectra relevant to cometary work. The spectra are well reproduced, but the text is marred by frequent misprints, and the review copy has been bound with Plate I missing.

A. HUNTER

Last of the Curlews

By Fred Bodsworth. Illustrated by T. M. Shortt. Pp. 123. (London: Museum Press, Ltd., 1956.) 10*s*. 6*d*. net.

THE story of man's reckless attacks on wild-life ever makes sad reading, whether it be the extermination of the once almost numberless passenger pigeon flocks, or the near extermination of the great bison herds. North America has been the scene of much destruction among birds and mammals and Mr. Bodsworth has an especially grievous story to tell of the beautiful Eskimo curlew that once flew from Patagonia to the tundras which slope into the Arctic waves. He tells the lamentable facts as a tale of two of the last individuals, prefacing his first chapter with the following words ". . . the Eskimo curlew, originally one of the Continent's most abundant gamebirds, flew a gauntlet of shot each Spring and Autumn, and, flying it, learned too slowly the fear of the hunter's gun that was the essential of survival. Now the species lingers on precariously at extinction's lip".

The tale is beautifully written and charmingly illustrated by T. M. Shortt, but it is a sorrowful story down to its last line, which depicts a male, whose mate has lately been shot, returning to his home corner of the Arctic tundra and there waiting for her.

The story assumes that a few individuals of *Numenius borealis* do still survive, but let us not forget that this assumption may be over-optimistic and that the Eskimo curlew can already have joined the great auk and the passenger pigeon in the limbo of things wiped out by man.

FRANCES PITT

The Status of Animals in the Christian Religion

By Major C. W. Hume. Pp. x+102. (London: The Universities Federation for Animal Welfare, 1956.) 8*s*. 6*d*. net.

THIS is a courageous, good, and in many ways delightfully heartening book; to be recommended without hesitation to any thinking Christian concerned, however remotely, with the welfare of animals. The first part deals with the historical origins and development of the present apathetic theological attitude towards pain and suffering in animals other than man. This, Major Hume traces to the effect of Platonic thought on science and Christianity, in arguments admirably set out and both lucidly and readably expressed. I would contend that the continued necessity of slaughter for the protection and feeding of man has probably contributed as much to this state of affairs as Platonism. However, views on its origins in no way diminish our proper concern with the problem itself. Some must feel it logically unsound to maintain the sinful nature of cruelty while nicely distinguishing this from killing, even if it is a matter of expediency dependent upon the impossibility of forcing vegetarianism on mankind. Yet who can resist the argument when St. Chrysostom and Darwin combine to demonstrate that we should show animals "great kindness and gentleness... because they are of the same origin as ourselves"?

The second half of the book comprises an excellent exposition of the 'proper status of animals' and of the proper attitude of Christians towards them. Both the present policies of several Christian bodies and possible improvements in the official Anglican views on the matter are considered. The hundred-odd drawings by Fougasse, illustrating biblical references to animals, are a little disappointing. They charm, of course, but the poor quality of the reproduction at so small a size makes many of the lines far too heavy and they do little to supplement the text.

RICHARD BAINBRIDGE

Rare Earths in Biochemical and Medical Research

Edited by Granvil C. Kyker and Elizabeth B. Anderson. (A Conference sponsored by the Medical Division, Oak Ridge Institute of Nuclear Studies, October 1955.) Pp. xviii+468. (Washington, D.C.: Office of Technical Services, Department of Commerce, 1956.) 2.20 dollars.

THE chemistry of the rare earths, their separation and their radio toxicity have assumed considerable importance with the rapid development of nuclear power during the past ten years. Thus, of the thirty-five or so elements produced in fission, the rare earths form an important part. The appearance of this unique collection of reports from nearly fifty investigators from the United States, together with the conference discussions, is therefore most timely. The reports are divided into five parts: chemical, radioisotopes of special interest, pharmacology, biochemical and metabolic and possible medical applications and dosimetry. A subsection on radiotoxicity studies of the rare-earth fission products is included and many articles are terminated by a list of references. It would be quite invidious to select any part for special mention, for the whole collection must surely be a most valuable source of reference to all whose interests are in this field. Indeed, the only regret is that the costs of production of such a report should not permit of a more durable binding.

THE BAGHDAD PACT NUCLEAR TRAINING CENTRE

By Sir JOHN COCKCROFT, O.M., K.C.B., C.B.E., F.R.S.

THE Baghdad Pact Nuclear Training Centre was formally opened by H.M. King Feisal II on March 31 in the presence of Ambassadors, Ministers and members of the Scientific Council of the Centre. The Centre has been founded by the Pact countries, Britain, Iraq, Iran, Pakistan and Turkey, to provide training in radioisotope techniques for scientists from the Pact countries and possibly other countries in the region. The laboratory has been provided by the Government of Iraq and was intended originally for date research. It is a pleasant building on two floors, adequately equipped for its purpose, with laboratories, lecture room, library and staff offices. The first technical director, Mr. W. J. Whitehouse, together with four other staff, have been seconded to the Centre by the Atomic Energy Authority in Britain. Eight staff from the Pact countries were trained at Harwell during 1956 and are now at their posts. The staff now cover the following fields: nuclear physics; radiochemistry; electronics; medical applications; and agriculture.

The equipment has been supplied by the United Kingdom, largely through Harwell, and consists of standard equipment of a radioisotope school adequate for twenty students together with the necessary supply of radioactive isotopes, text-books and reports. All member countries are contributing to the running expenses.

The first course for twenty students started in mid-April and will be similar in content and length to the Harwell Isotope School course. The present intention is to have three or four courses a year, some of which might be more specialized. For example, a course on the application of radioisotopes to medicine is contemplated. For this purpose the training staff would be strengthened by specialists from the United Kingdom.

It is intended that the Centre should promote the application of radioisotopes and atomic energy in the region by collaborating with existing laboratories and research groups.

A start will at once be made to collaborate with medical centres on the introduction of radioisotopes for diagnostic and therapeutic work. Other studies will be made in connexion with the oil industry and agriculture, and water conservation and control.

The Baghdad Museum, which has an extremely interesting collection of antiquities, is interested in obtaining help in establishing the carbon-14 dating method. The electronic specialists of the Centre may be able to help.

The application of nuclear power will not be worthwhile in Iraq and Turkey in the foreseeable future, owing to the abundant supply of oil and hydro power. Iran and Pakistan are, however, interested in the potentialities of nuclear power units of medium output for some areas, and the Centre will help by advice to promote this development.

The foundation of the Centre is an experiment in introducing the new techniques of radioisotopes to an important group of Middle East countries. Britain's role is to help by advice and by the provision of a few key staff.

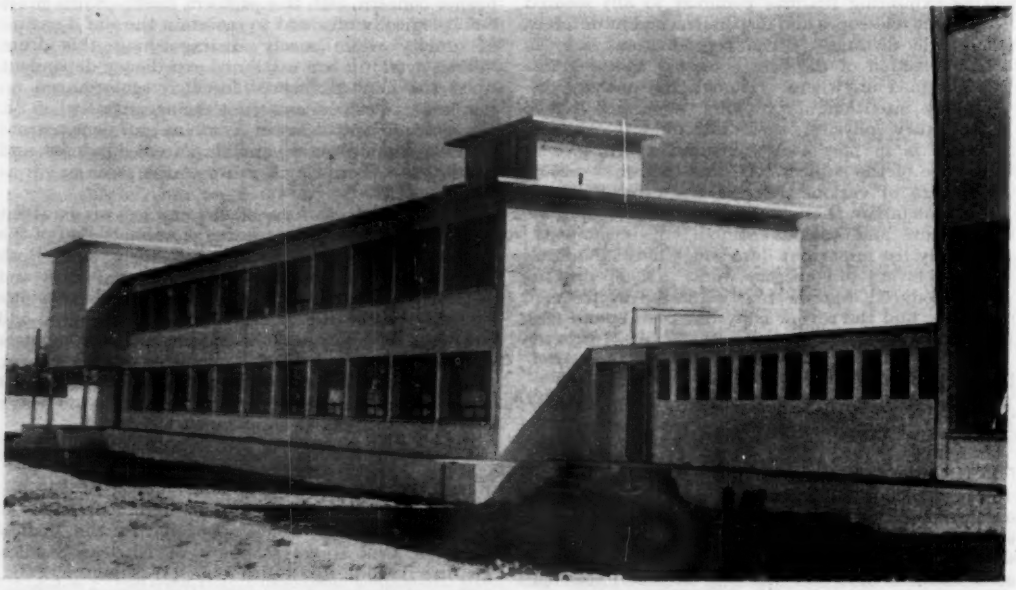

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Fig. 1. The Baghdad Pact Nuclear Centre in the district of Salchiyah in Baghdad

A NEW 75-IN. TELESCOPE FOR SAINT MICHEL OBSERVATORY, BASSES ALPES

By G. M. SISSON
Sir Howard Grubb, Parsons and Co., Ltd., Newcastle upon Tyne

THERE are still those who believe that astronomy is largely concerned with the careful compilation of star positions and magnitudes, whereas in fact it has become as diversified and specialized as any other branch of science. It is therefore rather surprising that the only major development in the optical design of large astronomical telescopes since the seventeenth century has been the family of catadioptric systems based upon Schmidt's first camera made in 1930. However, this new arrival is far from displacing the conventional parabolic reflector, which remains in the opinion of many the most useful general-purpose type of telescope; the advances in observing technique have been chiefly concentrated upon improving the quality of the images, the mechanical precision of the mounting, and the sensitivity of receivers. The large telescope mounting which has just been completed in the works of Sir Howard Grubb, Parsons and Co., Ltd., for the Centre National de la Recherche Scientifique, Paris, exemplifies these trends; it is arranged for work at the prime, Newtonian, Cassegrain or coudé focus, and will now be installed at the St. Michel Observatory near Fourcalquier in the Basses Alpes (Fig. 1). Apart from normal photographic procedures, the telescope will be used by Prof. A. Lallemand in conjunction with the new type of image receivers which he is developing.

The mirrors will be made at the Observatoire de Paris under the direction of Dr. A. Couder, who already has a large disk for the main mirror which will be 75·9 in. in diameter and 7·2 in. thick, with a focal length of 378 in. This is exceptionally thin for its diameter, and will be difficult to support properly in its cell on the telescope and during working. The cell holding the mirror on the telescope is insulated internally and closed by day with a petal-type of shutter having insulated flaps; by this means the mirror can be held at a reasonably constant temperature near the average night temperature. The mirror is carried upon three concentric rings of support pads 1·6 in. in diameter the axial force of which is applied in each case through a vertical toggle by a lever and counterweight with lever ratio 5 : 1 (Fig. 2). In the outer ring there are three rather larger rigid supports which locate the mirror and afford a squaring on adjustment. Table 1 shows the details of these supports.

Table 1

Ring position	Radius (in.)	No. of floating pads	No. of fixed pads	Load per pad (lb.)	Load per ring (lb.)
Inner	12·6	6	Nil	110	660
Middle	25·4	12	Nil	108	1,285
Outer	36·6	12	3	46	686
Total	—	30	3	—	2,640

Radial support and location are afforded by three lead-faced pads bearing upon the circumference of the mirror over an area of 7·9 in. circumferentially by 5·6 in. axially, located in the plane of its centre of gravity. Each of these pads is held against the glass by a screw with a flat end, and between this screw and the pad there is a ball to permit alignment and a small amount of axial translation. In use, the screws will be set hand-tight until the pads just hold the mirror comfortably. The arrangement of

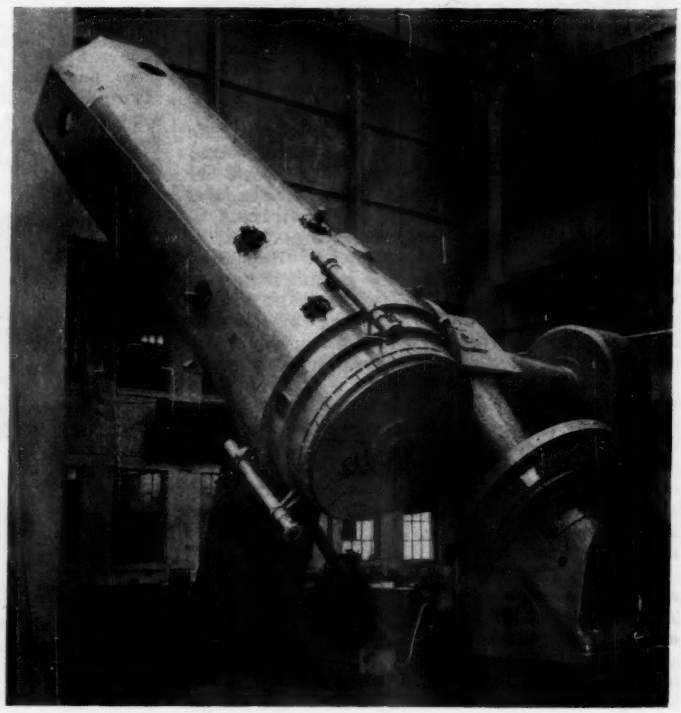

Fig. 1. A general view of the completed telescope mounting assembled in the makers' works

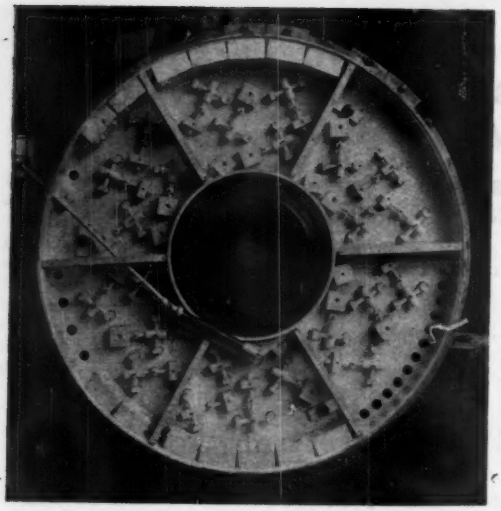

Fig. 2. Underside of the mirror cell showing the levers supporting the mirror

back supports is conventional for flexible mirrors, but the very simple type of edge support has not been tried before on anything approaching this size of telescope. All the support system was decided in principle by the French astronomers and designed in detail to meet their requirements.

The general form of the mounting is 'modified English', a well-proved conventional arrangement. To permit the coudé beam to pass down the polar axis, the declination axis is necessarily shorter than one would wish, having regard to the overhung weight of the main tube. Two taper roller bearings are used with an axial separation of 22 in., the inner one being 26 in. in diameter to the rollers and the outer 42 in. in diameter. These bearings are preloaded on assembly to a load of 15½ tons, and in service have to carry an overhung load of 14 tons at a distance of 54 in. beyond the outer bearing. The taper roller bearings together with a number of spur-gear engagements in the quick-motion driving system result in a frictional stiffness to turn of some 500 lb./ft., corresponding to a force of 20 lb. at the end of the telescope tube. By using the guiding motion of 30″ of arc per min., the end of the tube can be adjusted reliably to within 2×10^{-4} in., corresponding to an angular accuracy of 0·14″ of arc which may be needed if the good-seeing expectations are realized.

The final drive to the polar axis is imparted by a worm driving a worm-wheel 8 ft. in diameter having 960 teeth; the combination gives a smooth drive with an accuracy within ½″ of arc over a period of several hours. The input to the gear train is a conventional McMath–Hulbert system controlled by a tuned oscillator constant to within 1 part in 10^6 at any selected frequency over a range of ±1 per cent of sidereal rate.

However, the most notable innovation in the design is the use of an air-conditioned telescope tube. Astronomers have for long tolerated the image enlargement which results from disturbances and unequal temperatures in the air through which the light to the telescope must pass. The effect of these is to produce a spurious enlargement of star images called the shimmer disk, varying from 2″ of arc down to perhaps ½″ of arc in the most perfect 'seeing'. The shimmer, which is far larger than the Airy disk, results in a loss of speed and resolution, and improvement in seeing has been sought by the selection of favourable sites where good air conditions for observatories are known to exist. Within the past few years, opinion has been growing that much of the trouble is caused by local air conditions in the immediate neighbourhood of the dome opening and telescope tube. The subject was discussed by Couder at the Rome meeting in 1952 of the International Astronomical Union, and from the first it has been intended to arrange the St. Michel telescope for air-conditioning of the dome and tube. The dome opening is fitted with a circular aperture which rises and falls in the slit with blinds above and below; this aperture will normally be set centrally in front of the telescope tube. Air will be drawn into the dome by large fans in the building and some of this air will flow past the outside of the telescope tube, so preventing any warm air in the dome from rising into the light path; the rest of the air will enter the open end of the tube itself (Fig. 3). The tube has a double wall, the outer one of sheet duralumin and the inner one composed of panels carrying fine woven nylon. The panels are easily removable for cleaning or renewal of the nylon, and the weight of weave in each was selected to give the desired air-flow pattern inside the tube. Extraction through the cloth drops from 3 ft. per sec. near the upper end to 0·2 ft. per sec. at the lower end; some of the panels were sprayed with a uniform pattern of black cellulose paint spots to modify their permeability. Eight 15-in. propeller fans are arranged around the base of the tube just above the centrepiece, and each of these exhausts a manifold formed between the two walls and reaching nearly to the top of the tube. A further four 12-in. fans are arranged around a manifold which girdles the centrepiece, and three 9-in. fans are mounted behind the mirror cell. Of these last three, two draw air through a circumferential slot between the face of the mirror itself and its cell, while the third draws air through a similar slot surrounding the central hole in the mirror.

Fig. 3. Top end of the telescope tube with streamlined air entry

The intention of all this is to draw air into the top of the tube with a velocity of about 30 in. per sec., the air being removed progressively through the fine-mesh panels in the inner tube wall until finally a small residue of the volume originally induced actually reaches the surface of the mirror. This air is then withdrawn with radial symmetry across the face of the mirror through both the inner and the outer slots. All the fan speeds are adjustable at will over a wide range, and working trials will determine the best settings.

Experiments made at the Cambridge Observatories during the past year have shown that air-conditioning even of a comparatively simple nature can give it great improvement in seeing conditions there; a remains to be seen how effective a carefully planned system can be when applied to a large telescope at a favourable observing site.

SCIENCE IN HUNGARY

By Prof. J. D. BERNAL, F.R.S.
Birkbeck College, London

SCIENCE teaching and research have been fully restored in Hungary. The damage caused in the fighting last autumn was, fortunately, on the whole slight. The only serious loss was the almost complete destruction of the natural history collections in the burnt-out National Museum [see following article]. The damage to the University was largely confined to the Geology Department. The material damage has been restored; but there is a serious loss of books on stratigraphy and palæontology. In the University it is estimated that by lightening the courses and extending the term resumed in February, it will be possible to complete the work of the session.

The course of research work has been even less interrupted. The Academy and its institutes under the direction of Prof. Rusznyák are in full activity. In the Institute of Physics, the building for the nuclear research pile is nearing completion, and researches on nuclear physics, magnetism, spectroscopy and solid-state physics are being carried out. Prof. Jánossy is continuing his study of extended cosmic-ray showers and the phenomena of interference at low intensities.

There is much activity in the University research departments such as those of Prof. Erdey-Gruz and Dr. Lengyel in electrochemistry and the properties of concentrated ionic solutions. Prof. Straub is extending his work on enzyme synthesis by nucleic acid fractions, particularly for bacterial penicillinase, in conjunction with one of his students at present at the Medical Research Council laboratories at Mill Hill. In the Geology Department, Prof. Szadeczky-Kardoss is obtaining very interesting results in the high-pressure and temperature modifications of lignite and shales. At the Technical University, Prof. Gyulai, one of the first to study the properties of crystal 'whiskers', has discovered new related phenomena involving dislocations.

More significant, however, than the continuation of work in progress is the effort that is now being made to re-organize the whole scientific activity of the country to eliminate the errors and distortions of the past and to bring it into relation with a more realistic planning of industry and agriculture. In this replanning, scientists are playing a much more important part than formerly, for it is realized that the undertaking of the over-ambitious and misdirected industrial enterprises of the former regime could have been avoided if responsible scientific and technical advice had been taken in the first place. Scientists and engineers such as Dr. Gillemot, the rector of the Technical University, and Dr. Zentai and Dr. Valko, prominent in M.E.T.E.Sz., the organization of the scientists and technicians, are putting forward a scheme of central and specialized research and development councils on lines somewhat similar to those of the Department of Scientific and Industrial Research. They are also helping to draw up plans for Hungarian industry aimed at making fuller use of the special natural resources of the country, such as bauxite and uranium, and of its established industrial lines of production such as diesel engines, communication equipment and instruments. This would bring Hungary more in line with other small countries with specialized economies, such as Switzerland and Denmark, which would make it correspondingly more dependent on external trade and technical and scientific relations with other countries.

Hungarian scientists are anxious to renew and extend the contacts with British scientists broken off by the recent troubles. They would welcome an exchange of letters and reprints and also of individual visits which could now take place, thanks to the resumption of the tourist traffic.

THE HUNGARIAN NATURAL HISTORY MUSEUM

THE collections of the Zoological Department of the Natural History Museum in Budapest, built up over the past hundred and fifty years, are well known; they represent the life-work of scientists such as János and Imre Frivaldszky, János Salamon Petenyi, Géza Fejérváry, Géza Horváth, Sándor Mocsáry, Ernő Csiki, Kálmán Kertész, Gyula Madarász, to mention but a few. The collections contain not only the most complete Hungarian, that is, Carpathian fauna, but are also very rich in palæarctic and exotic material. Zoological material gathered by the collecting expeditions of Hungarian explorers have been deposited in the Museum; the names János Xántus, Lajos Biró, Kálmán (Katona) Kittenberger are well known in scientific circles. Xántus brought home a great deal of material

including examples of all animal groups from Eastern Asia. Six years collecting in New Guinea by L. Biró produced many species, especially of insects, that were new to science. Kálmán Kittenberger explored the big game and ornithological fauna of East Africa. Nothing now remains of a large part of the collections.

The events in Hungary during October 23 and November 4, 1956, are well known. In the first stage of the revolution the building of the National Museum, situated on the Museum Boulevard, and the collections stored in it were badly damaged. This historic building, which is more than a hundred years old, received heavy gunfire from tanks during the battle for the broadcasting station near by. As a result, the building caught fire and a part of it was destroyed. The fire originated in the rooms of the Mineralogical Department. Conditions prevented the fire brigade from taking effective action, and eventually the Mineralogical and Palæontological Departments, and also a large part of the exhibitions of the Zoological Department, were completely destroyed.

The exhibits in the Zoological Department, all of which had been constructed within the past eight years, were widely known. The African exhibit, with its great dioramas, drew numbers of visitors every day. The diorama of the Ruwana steppe, which was 25 metres long, always aroused admiration, for the team of preparators had succeeded in conjuring up a true picture of Nature. All these exhibits have been destroyed or so badly damaged that their repair is well-nigh impossible. The big diorama was burnt down, together with the elephant, gazelles, zebras, gnus, boars, etc. Even the iron framework supporting the lion, chimpanzee, white rhinoceros and ostrich dioramas melted in the heat. The crocodile diorama was destroyed by a shell from a tank. The introductory part of the African exhibit, with its trophies, was not burnt, but the heat and smoke have damaged it so badly that a great deal of the material has become useless. A mortar exploded in the invertebrate exhibition, destroying most of the tropical display material.

At this stage of the revolution no damage was done to the scientific and research material of the Zoological Department. But during the artillery and mortar barrage on November 5 the Museum building was again hit. The first mortar went through the window of the herpetological collection on the second story of the Museum during the morning. The explosion set fire to the alcohol pouring from the broken jars, and within a few minutes the entire contents of the large room housing the collection were in flames. Then a mortar exploded in the ichthyological collection. This shell brought down the wall of the ornithological collection and the flames were able to spread unhindered. In a few hours the whole of the second floor of the Museum was in flames. The main staircase was partly destroyed and part also of the back stairs. Burning alcohol set fire to the third floor and the roof. Continual shell-fire prevented any attempt at rescue. By great self-sacrifice and much hard work, it was possible to save one wing of the Museum, and also the front of the third floor of the building.

It is impossible to estimate the value of the material lost and destroyed. The following collections were destroyed down to the last specimen: the herpetological collection of about 30,000 specimens, the ichthyological collection of about 10,000 specimens, the ornithological collection containing about 40,000 skins, 30,000 eggs, and 2,500 skeletons, the big-game bone collection, mainly African mammal material, the molluscan collection of about half a million specimens, the collection of lower invertebrate animals, echinoderms, corals, worms, etc., housed in ten cases, the water mite collection which contained many thousands of preparations and preserved material, and included all the type material of Szalay, and the identified Orthopteroidea and Neuropteroidea collections consisting of 400 boxes in ten cabinets and including many hundreds of types, among them the Orthoptera collection of K. Brancsik. But the greatest loss of all, from a scientific point of view, is the Diptera collection, containing the types of many thousands of species; only three cases of Acalayptrata material escaped destruction because it was stored elsewhere owing to lack of space in the main room.

The collections which were spared also suffered some damage. The collections stored on the first floor were flooded with water from the fire-fighting operations, and the greatest losses were suffered by the Hemiptera–Homoptera collections. Almost 10 per cent of the famous Horváth material was destroyed, and a further 10 per cent was damaged by water. In the same collection, mortar fragments damaged two cases and the contents of several boxes were pulverized. Part of the Coleoptera collection, the biggest in Europe (the number of types in the collection exceeds 10,000), was also soaked, but luckily only Hungarian material was stored in the boxes that became very wet, and it should prove possible to replace these specimens. Some boxes of the Reitter collection became wet, and some types were lost.

The departmental libraries were lost, together with the collections. In the Diptera section alone 6,000 reprints and 1,500 books were destroyed. In the Hemiptera–Homoptera section the reprints were torn by shrapnel and some 1,000 copies became useless. The library of the Lepidoptera section was drenched with water, and valuable books, colour charts, etc., made useless.

The Lepidoptera collection escaped by a hair's-breadth; the window frames and door caught fire and half the T. Koy collection which stood near the door was burnt. This collection is of historical importance since it dates from 1800. The backs of some of the cases containing exotic butterflies were charred; the boxes and cases were scorched, but the collection was saved. The collection also suffered from the fire-fighting operations, and some dozens of boxes were drenched with water so that more than 10,000 butterflies and moths will have to be reset. Many boxes were broken when the ceiling fell on them. Only the Hymenoptera, Crustacea and Arachnoidea collections escaped intact.

Every effort was and is being made to secure the safety of the collections that have survived. Every research worker and the entire staff of the Museum co-operated in rescuing unharmed and damaged collections from the ruins of the building, often endangering their lives, and as a result the surviving collections are safe.

The replacement of the destroyed collections, their reorganization, the acquisition of equipment and scientific instruments and the replacement of the libraries is now the first task of the Zoological Department. The burden imposed on the Department is greater than it can bear alone. Scientific institutions, museums, scientific societies and foundations and also private individuals are asked to help the Museum with specimens, books, reprints, etc.

MACROMOLECULES IN CELL STRUCTURE*

By Prof. A. FREY-WYSSLING

Swiss Federal Institute of Technology, Zurich

DURING the present century biology has developed along three different lines, so that—by analogy with Cæsar—we can say: Biology *est omnis divisa in partes tres, quarum una Taxonomia aliaeque Morphologia et Biochimia.* As in pre-Roman Gaul with her particularism, there has not been much co-operation between those branches. Especially microscopic morphology (cytology and histology) and biochemistry (or physiological chemistry), which ought to represent general biology together, were divided into two almost hostile camps. The chemist laughed at the descriptive methods of histology, and the histologist thought very poorly of the chemist's endeavours to draw physiological conclusions from the analysis of disintegrated and badly intermingled systems such as their homogenates. As a matter of fact, the two sciences were too far apart for fruitful discussion, since one worked with microscopic objects and the other with amicroscopic molecules. However, in between those domains the colloidal or submicroscopic range is inserted, which had to be bridged before reciprocal understanding and appreciation between morphologists and biochemists was possible.

During the First World War, Ambronn developed methods for getting an insight into the submicroscopic arrangement of colloidal particles in gels with the polarizing microscope. When I used those methods for the elucidation of the fine structure of plant cell-walls, starch grains and chloroplasts, one of my older colleagues disdainfully remarked that mine was a hybrid science. Fortunately, hybrids often show the phenomenon of heterosis, which has effectively worked in the case of submicroscopic morphology by the introduction of such elegant methods as X-ray analysis and electron microscopy. To-day, biophysics permits the macromolecules to be traced in many biological objects, and if their molecular structure is known, morphology can be extended down into the chemical range; and on the other hand, chemistry may learn from the arrangement of macromolecular apoenzymes how chain reactions, which are blocked in a homogenate, proceed in the intact cell structure. In this way submicroscopic morphology can be appealed to to unify the morphological and the chemical branches of general biology into a single and undivided science, of the problems of which the following instances may be presented.

Plant Cell Walls

Meristematic plant cell walls represent a mixture of an amorphous pectic matrix in which submicroscopic fibrils of cellulose are embedded, comparable to the structure of the connective tissues with collagen tonofibrils reinforcing a hyaluronic ground-mass. The microfibrils have diameters of approximately 250 A. They consist of a bundle of parallel molecules of cellulose, the chemical structure of which has been found to be a straight unramified β-1-4-glucosidic chain of more than one thousand glucose residues and a length of up to several microns. Since the microfibrils are crystalline, their internal structure can be determined by X-ray analysis. A monoclinic lattice is found with an antiparallel arrangement of the cellulose chains (Fig. 1).

This antiparallel orientation indicates that polymerization of glucose or some other precursor to cellulose and crystallization into microfibrils must take place at the same time, since it seems impossible that free diffusible chain molecules with a width/length ratio of 1 : 1,000 would become arranged spontaneously in such a manner.

The amount of cellulose microfibrils in primary walls is astonishingly small. It covers only a few per cent by volume of the fresh wall taken from living cells. This compares favourably with about 5 per cent of reinforcing iron in concrete, so that the primary wall is obviously sufficiently reinforced by so small an amount of skeleton material to give it strength.

In primary walls the microfibrils are originally dispersed at random. Extension growth or growth in surface may orientate them to some extent. More conspicuous changes occur by differentiation pheno-

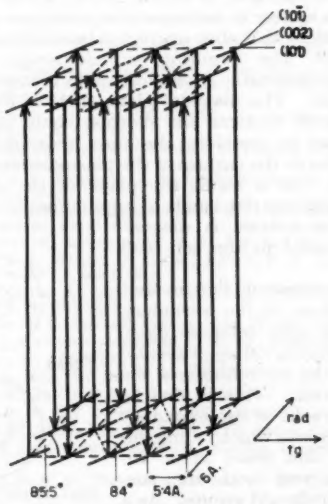

Fig. 1. Macromolecular structure of cellulose strands. The arrows indicate the direction of the antiparallel chain molecules. The body represented contains the cross-section of four unit cells of the chain lattice. *tg*, tangential; *rad*, radial direction of the cell wall

* Substance of three lectures at University College, London, on March 12, 13 and 15, based on the two monographs, Frey-Wyssling, A., "Die submikroskopische Struktur des Cytoplasmas" (Springer, Wien, 1955) and "Macromolecules in Cell Structure" (Harvard University Press, Cambridge (Mass.), in the press).

Fig. 2. Electron micrograph of the so-called margin of a nascent bordered pit. × 15,000

mena. When plasmodesmata or pit membranes of bordered pits are formed, certain microfibrils are pushed aside or gathered into coarser strands, so that open holes result through which the protoplasts of two neighbouring cells can join. Fig. 2 shows how, in an annular zone around the so-called torus of a bordered pit, radial microfibrils coalesce into coarser strands, while tangential microfibrils do not associate. In this way radially arranged pores originate in the young pit membrane and later unite into radial splits[1c].

In the secondary plant cell wall the content of cellulose is considerably higher than in the primary wall. It can rise to more than 90 per cent of the dry wall, as, for example, in cotton hairs. Therefore the microfibrils appear in dense parallel packing and touch one another, so that they aggregate laterally and form fasciations[1b]. The resulting submicroscopic sheets have a characteristic crystallographic orientation in the cell wall. The diagonal plane (101) of the chain lattice, which contains the shortest chain distances (5·4 A.) and is, therefore, the most hydrophilic one, runs parallel to the surface of the plasmalemma of the protoplast. As a result the plane of the cellulose chains, which are flat bands of approximately 4 A. × 8·4 A. cross-section, is diagonally orientated in the cell wall (Fig. 1).

Another amazing fact is that only cellulose of the secondary wall reacts with cellulose dyes, as, for example, iodine, which do not stain the microfibrils of the primary wall. This is due to cleavage cracks in the secondary microfibrils into which iodine can penetrate and react in a co-ordinative way with the surrounding hydroxyl groups. As a consequence of this defective crystalline structure, cellulose of secondary walls can be split by ultrasonic waves into strands finer than microfibrils, which are called micellar strands. They contain an ideally crystalline core and probably a surface layer of less orderly arrangement (paracrystalline cellulose). According to their cross-section of 30 A. × 100 A. to 50 A. × 60 A. they contain about 100 cellulose chains. The coarser microfibrils with 250 A. diameter already hold 2,000 chain molecules. Since the texture of the microfibrils and their relations to the microscopic morphology of the plant cell wall are established, the structure of the cellulosic component of this wall is known from the macromolecular chain molecule up to the macroscopically visible plant fibre. Therefore, in the case of cotton hair, which is almost pure cellulose, we are dealing with a biological object the structure of which is thoroughly well known throughout the domains of morphology from the macroscopic and microscopic down to the submicroscopic and amicroscopic level[2].

Chloroplasts

The chlorophyll-containing chromatophores or chloroplasts have a submicroscopic layered structure. This has been proved by the establishment of their lamellar form birefringence[3], by X-ray analysis[4] and finally by direct electron microscopic evidence[5–7]. In higher plants the chlorophyll is not evenly distributed throughout the chloroplast, but is restricted to tiny flat bodies which are called grana. In the light microscope they seem to be suspended in the colourless stroma, but in the electron microscope they appear to be layered in disks. These are flat bags which originate by local splitting and duplification of the stroma layers. They grow into fairly independent and firm bodies (Fig. 3) because, on ultrasonic distintegration, they resist whereas the layered stroma is completely destroyed[8]. High-resolution electron microscopy shows that these disks have a granular structure. The constituent globules have a diameter of approximately 65 A. which corresponds to their thickness on ultrathin sections (Fig. 3). From this I concluded that they represent globular protein macromolecules. Their size corresponds to about 4 Svedberg units. At their surface chlorophyll and lipids may be inserted to form chromo- and lipoproteins. It has been claimed that the tiny lines which bisect the spaces between and inside the disks (Fig. 3) represent the delimitation of lipidic surface layers[7]. The material inside the disks is very sensitive to swelling and the disks can be inflated into balloons[8]. Calculations show that about sixteen chlorophyll molecules must be associated with such a particle. Since it has about the same weight as

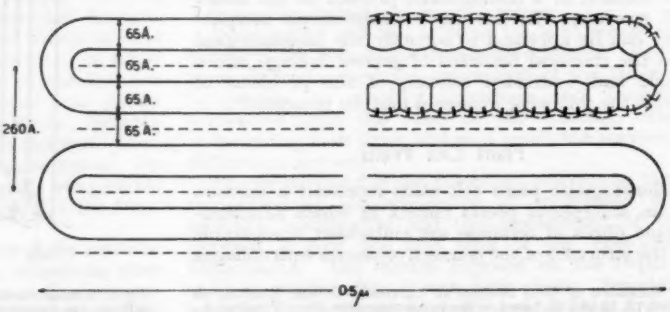

Fig. 3. Macromolecular structure of a grana disk shown in cross-section. ⌐, chlorophyll molecules

hæmoglobin (mol. weight 68,000) with only four hæms, the hypothetical chromoprotein of the chloroplast must be four times richer in pigment than hæmoglobin. The outer surface of the densely packed particle is of the order of (65 A.)[3] and that of a porphyrin ring (15 A.)[3], so that the sixteen chlorophyll molecules mentioned can easily be located at the outer surface of these macromolecules. However, since the dichroism of the chloroplast is very weak[3], there cannot be a plane surface film, but some undulating arrangement as indicated in Fig. 3.

Proplastids are amœboid in character and do not show a lamellar structure. They include a tiny body which contains nucleic acid[10]. It has been called a primary grain by its discoverer Strugger[11]. In the electron microscope it displays a structure similar to that of protein crystals[12,13]. High-resolution analysis shows, however, considerable differences as compared with a crystal lattice (Fig. 4). The globular particles do not touch one another and they seem to have a hollow core[14]. This centre produces the submicroscopic layers when the proplastid evolves and then differentiates into a chloroplast. It seems plausible that this organizer produces new macromolecules by autoreproduction, and apparently a beautiful object is found to follow that mysterious process in the electron microscope. But the situation is complicated by the fact that, as with the erythrocyte, the full-grown chloroplast is very poor in nucleoprotein[15]. Therefore, the macromolecular lamellæ produced by the primary grain cannot consist of autoreproduced nucleoprotein. Since they represent lipoproteins capable of producing chlorophyll, we are observing the formation—not of identical daughter molecules—but of a new type of macromolecules. This neoformation of specific protein molecules, which were not present in the cell beforehand, is a phenomenon far more exciting even than the much discussed problem of autoreproduction.

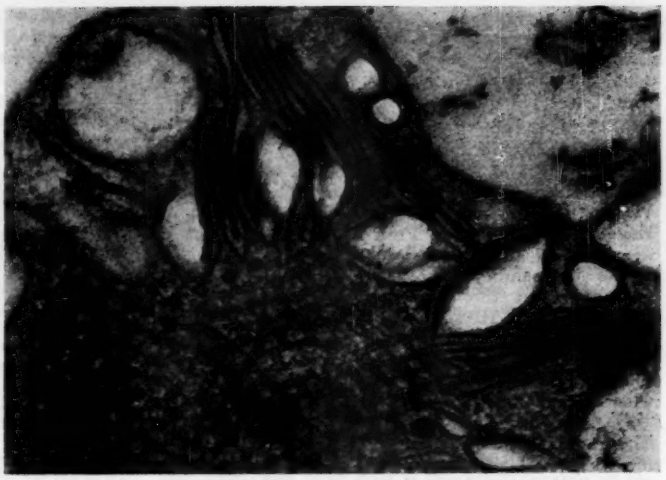

Fig. 4. Electron micrograph of the so-called primary granum in a proplastid (from Perner, ref. 14); by courtesy of Prof. S. Strugger, Münster. × 86,000

Cytoplasm

Depending on its functions, cytoplasm displays a granular, fibrillar or lamellar aspect in the electron microscope. In many cases it could be shown that protein microfibrils (collagen[16], muscle[17], flagella[18]) and lamellæ[19] are composed of globular or rod-like particles. Accordingly, the basic element of the living substance seems to consist of particulate macromolecules which are capable of aggregating into reticulate, fibrillar or lamellar structures. As macromolecules of protein, they have a helical internal structure[20] which shows regularities similar to certain macroscopic helical arrangements in biology[21].

The pressing problem of biochemistry is to establish how those particles associate with lipids, pigments or carbohydrates to form lipoproteins, chromoproteins and mucoproteins, while submicroscopic morphology has to find out how such macromolecules aggregate into one-, two- or three-dimensional patterns. The forces which cause these associations and aggregations are rather weak, because the bonds resulting from their activity are easily broken. This explains why cytoplasm can freely and reversibly change from the state of plasma sol, which is a non-Newtonian liquid, into that of a rigid and elastic plasma gel[22].

The formation of a linear aggregation into fibrils requires two polar fields of attachment, that of a macromolecular film of three or six fields lying in one plane, and that of a reticular system of at least four such fields at the surface of each particle. In protein crystals with dense packing, this number is even twelve. The figure which indicates how many fellow globules are needed to build a plasma structure around a particle may be called its co-ordination number.

It is thus possible to explain the various and manifold structural manifestations of cytoplasm in submicroscopic morphology by a uniform principle.

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AQUA VITÆ

A MEETING of the Nutrition Society was held on March 23 at the Royal Society of Medicine. It took the form of a symposium on "Man's Need for Water", and members of the Institution of Water Engineers were present. Prof. R. A. McCance was in the chair.

The symposium was opened by Dr. W. H. Cremer, who discussed the "Water Requirements of the Modern State". He spoke of the large reservoirs and long pipe lines necessary to provide enough water for some large industrial cities, but he had to admit that this was all very costly and not always popular where the reservoirs had to be built.

Dr. Cremer also spoke of the possibility of replenishing underground supplies of water by suitable filtration through the soil. This is an interesting prospect, but he did not touch upon the expense. Re-charging these underground supplies is evidently being investigated actively at the moment. The industrial demands for water are becoming more and more difficult to meet and the contamination of the water by the industries brings further problems. Chlorination still seems to be the sheet anchor against bacterial infection, and people do not seem to mind the taste of chlorine, although they object to that of many organic compounds which can get into a water supply in all sorts of ways. Those present were surprised when Dr. Cremer tried to persuade them that something like half the water distributed in America is used, not for industry, but for agricultural irrigation. The audience felt they were being taken over more familiar ground when Dr. Cremer spoke about fluoridization of water and iodine deficiencies. He said little about metallic poisoning, but the detergents that are now used so freely and run away down the sink are likely to cause water engineers some very serious difficulties. After a word on radioactive poisoning, Dr. Cremer concluded his remarks. He seems to see no problem over the supply of water in Britain in the foreseeable future in spite of the cost and organization involved. Some of us would like to have heard more about the problems created by the rising populations in other parts of the world, and the industrial development of dry parts of America. Confident as Dr. Cremer appeared to be in the future, one could not help thinking about the great aqueducts and storage tanks built in Ceylon, Central America, Italy and other parts of the world by past civilizations, and hoping that a fate similar to theirs would not befall our own.

Dr. J. R. Robinson gave an elegant account of the functions of water in the body. The extracellular fluids or 'middleman fluids' of the body he likened to a pond in which the cells lead an aquatic existence; but the cells are not quite like amœbæ in a fresh-water pond, for the pond in the body is warm and salt. It is, moreover, small in volume, so that the activity of the cells affects the composition of the pond. The cells are intolerant of changes in external composition and temperature and "a great part of physiology is concerned with mechanisms which enable the little over-crowded pond under our skins to maintain our cells as though it had an unlimited volume".

Dr. Robinson then pointed out that some of the chief functions of water in the body could only be fulfilled by losing it through the kidneys, lungs and skin. These losses must be made good if the cells are to function normally, for water is the great vehicle of transport in the body, and transport will break down if the volume of the blood, and of the extracellular fluids as a whole, is reduced. Dr. Robinson reminded his audience that, generally speaking, cell membranes are permeable to water, so that the volume of a cell in equilibrium with an environment with a constant osmotic pressure will be proportional to the quantity of solutes inside it, and this is profoundly affected by metabolic activity. Here Dr. Robinson was touching on a subject to which he has made major contributions, for he himself has shown that interruption of cell respiration by chilling, anoxia or poisoning with cyanide causes cells to swell. So long as metabolism is proceeding normally, however, the osmotic pressure of the extracellular fluid is the most important factor in controlling the net exchange of water between the cells and extracellular fluid. This being so, thirst and water diuresis are really the means by which the volume and osmotic pressure of the extracellular fluids and also the volume of the intracellular fluid are both kept constant. Dr. Robinson concluded with the thought-provoking remark: "The kidneys control the volume of water inside the cells by excreting water, and the volume outside the cells by excreting salt".

Dr. J. R. Elkinton, of Philadelphia, gave the next paper, which was on the relationship of water and salt. He took his audience into the realms of the palæochemistry of the earth and its relation to the evolution of body fluids. He compared the composition of the extracellular fluids with that of sea water and described the suggestion made more than fifty years ago that the composition of vertebrate extracellular fluid is a heritage of the ancient seas in which such organisms first evolved. He referred to Conway's calculations concerning the chemical evolution of the ocean. As the rain dissolved the original igneous rock of the Earth's surface, washing the solutes into the sea, sedimentary rock was formed by precipitation. In this rock was the potassium, magnesium and calcium, whereas sodium salts remained in solution in the sea water. Whether the mechanisms responsible for depositing potassium in the cell are similar to those involved in depositing it in the soil is a matter for speculation, but the fact is clear that potassium and sodium are distributed differentially in geochemical as well as in biochemical systems.

Dr. Elkinton then discussed what happened when organisms which began life in a salty sea found themselves in a hypotonic medium of fresh water. They had to develop such mechanisms as water-tight skins and glomerular kidneys to prevent themselves from becoming over-hydrated. If they chose to return to the hypertonic oceans they were then forced to protect themselves against dehydration, and various methods of doing so appeared, such as the physiological uræmia of the elasmobranchs, salt-secreting gills and so on. Animals and birds on dry land

acquired the ability to secrete a hypertonic urine, so that they were able to regulate their salt and water balance, and hence the composition of the internal environment.

Dr. Elkinton next posed the question, "How does the kidney know how much sodium and potassium to excrete ?", and he mentioned some of the mechanisms, the secretion of aldosterone, for example, which are known to play a part, but it is still not known what tells the adrenal cortex how much aldosterone to secrete. He concluded by describing some experiments of his own. In pure dehydration the concentrations of sodium and chloride in the serum rises, but the excretion of the two ions in the urine falls, whereas the excretion of potassium increases. This he interpreted as a conservation of extracellular fluid at the expense of intracellular water. In contrast, a deficiency of salt leads to a fall in the concentration of sodium and chloride in the extracellular fluids, and to a fall in their volume with a movement of water into the cells.

Dr. E. M. Widdowson opened the afternoon session with a paper on "Water Equilibrium in Health". She first described the sources of water, from drink, from food, and from water of oxidation, and the four routes by which water is normally lost—through the lungs, the skin, the intestine and the kidneys. A healthy person's kidneys can easily excrete all the excess of fluid he or she is likely to drink, but a shortage of water may be disastrous, and dehydration is always due to the losses of water from the body exceeding the intake. The losses by the lungs and skin go on whatever the supply of water and the state of hydration of the body may be ; only the losses by the kidneys vary with the intake and the requirement.

A baby loses more water by all routes than an adult in proportion to its body-weight and it therefore needs more fluid. If a man drank as much as a baby per pound of body-weight he would have to consume two gallons a day. Dr. Widdowson raised the question as to which would be able to survive longer when deprived of all water, an adult or a baby. Conventional teaching suggested that the baby would die sooner, but Dr. Widdowson was not so sure.

The effects of experimental dehydration were described, and Dr. Widdowson told the story of "The Welsh Fasting Girl", who was in the news nearly a hundred years ago. She was supposed to be able to live without any food or water, but when "four reliable nurses from Guy's Hospital" were sent to watch her night and day to prove or disprove the miracle she lived only eight days. Many at the time assumed that starvation had been the cause of death, but the records clearly point to dehydration. Dr. Widdowson concluded with a reference to the castaway at sea. Records collected from members of the Merchant Navy whose ships were sunk during the Second World War provide convincing evidence of the disastrous effects of drinking sea water.

The last two speakers handled the problem of the metabolism of water in disease. By a series of witty little rationalizations, Dr. D. A. K. Black managed to exclude salt from his programme and to limit his responsibility to water depletion and water intoxication. As has happened before, both these departures from the normal were well characterized experimentally before they were recognized to be relatively common in the wards. Even with water beside their beds patients may take far less than they need if they are comatose, lethargic or simply too weak to make the necessary effort. Œsophageal obstruction may have the same effect. Sweating and hyperpnœa may increase the loss and so may various renal abnormalities such as diabetes insipidus or, much more commonly, an inability to produce a concentrated urine. This can follow potassium deficiency as well as the more classical forms of nephritis. Dr. Black then made the point that the recognition of clinical dehydration demanded considerable fundamental knowledge coupled with a study of the patient's history and his disease.

Water intoxication remained a clinical rarity for many years after its first recognition and description by Rowntree in 1922. It has, however, recently been accepted as a dangerous feature in the treatment of patients who have for some reason ceased to pass any urine. Such patients often recover if given time, but the temptation to try to improve their chances by giving them water in large amounts by mouth must be avoided at all costs. Only enough water should be given to meet the losses by the lungs and skin, and even less than this is desirable because of the water which is always being produced inside the body by the oxidation of protein, fat and carbohydrate.

With years of experience behind her, Dr. Winifred Young gave the meeting a masterly exposition on the restoration and maintenance of water equilibrium in sick children. She went into the question of how to decide how much water and salt ought to be given within a few hours of admission to hospital, and then passed on to discuss the assessment of the infant's maintenance requirements. She touched upon the thorny question of how much, if any, potassium should be given intravenously, and stressed the impossibility of getting results back, even from a well-equipped laboratory, in time to do more than give one confidence, or the reverse, in what one had already done. She illustrated this by a vivid description of a dehydrated child which had been treated with too much water and not enough salt in preparation for an emergency operation. The child developed water intoxication, which was recognized clinically and treated. The surgeons did their part—and all was well.

A lively discussion followed both the morning and afternoon sessions. Dr. W. S. S. Ladell demonstrated from his own experience that troops in moderately hot climates might lose almost ten litres of water a day. Whether to drink sea water or to chew fish if cast away in a rubber dinghy received a good deal of attention, and questions were answered by Dr. J. R. Elkinton, Dr. G. R. Hervey and the chairman.

Dr. Windle Taylor, director of Water Examination at the Metropolitan Water Board, asked how much salt would be permissible in water which was provided for a patient on a salt-free diet, and was told that in the majority of cases the amount of sodium in tap water would not matter.

Dr. Cicely Williams suggested that in the tropics one of the chief causes of malnutrition was often gastro-enteritis and dyspepsia, which arose because water was not easily available, and the staple food was inadequately cooked in insufficient water.

Other people taking part in the discussion were Prof. J. Yudkin, Dr. R. J. L. Allen, Mr. A. L. Bacharach, Dr. D. C. Wilson and Miss D. Hollingsworth.

R. A. McCance
E. M. Widdowson

NEWS and VIEWS

Chemistry at Birkbeck College : Prof. W. Wardlaw, C.B.E.

To the very large number of scientists who know him personally, it will come as a real surprise that Prof. William Wardlaw has reached the age of retirement. Educated at Rutherford College, Newcastle upon Tyne, and at the University of Durham, he joined the staff of the Department of Chemistry at the University of Birmingham after the First World War and in 1937 he was appointed professor of physical chemistry in the University of London at Birkbeck College. For more than forty years Prof. Wardlaw has done valuable research in the chemistry of the transition metals, especially of molybdenum. His studies in structural inorganic chemistry, especially in the stereochemistry of metal complexes, have been important contributions in the field. His recent work on the esters of titanium and other elements of Groups IV and V has had important influences in the development of modern views on the relationship of certain physical properties and molecular complexity. Distinguished as a teacher, he has also given other unstinted service to his fellow chemists and other scientists. During the Second World War he was a joint secretary of the War Cabinet Scientific Advisory Committee, and since shortly after the War he has been scientific adviser to the Department of Appointments in the Ministry of Labour and National Service, where his wise counsel has been of great national benefit. He has rendered very distinguished service to the Chemical Society, being a member of Council during 1934–37, honorary secretary 1940–48, and its president in 1954–56. Likewise he has served the Royal Institute of Chemistry. He was on the Institute's Council during 1929–32, and again during 1933–36, was an examiner for the Institute from 1936, a censor from 1948, and now he is president. He was made C.B.E. in 1949. Scientists, especially chemists, owe Wardlaw a great deal. His shrewd evaluation of the importance of their relation to the community at large explains the active part he has taken in the affairs of the British Association. He has been secretary of Section B (Chemistry), was Section B president at the Belfast meeting in 1952, and since 1955 has been a general secretary of the Association. In this and other capacities, and especially as president of the Royal Institute of Chemistry, he will continue his active and beneficial participation in the scientific affairs of Britain.

Dr. W. G. Overend

Dr. W. G. Overend has been appointed to succeed Prof. William Wardlaw in the chair of chemistry at Birkbeck College. Born in 1921, he received his early education at the Priory School and at the Technical College, Shrewsbury, whence he proceeded to the University of Birmingham. He graduated with first-class honours in 1944, was awarded his Ph.D. in 1947 and his D.Sc. in 1954. In his first researches he was closely associated with the late Sir Norman Haworth and Dr. L. F. Wiggins in the Colonial Products Research Council's scheme for the utilization of cane sugar, specializing in the synthesis of heterocyclic compounds of potential pharmacological value. He joined the staff of the University College, Nottingham, in 1946, and in 1947 he was appointed a research chemist with the Dunlop Rubber Company. In 1949 he returned to the Chemistry Department of the University of Birmingham as a Fellow of the British Rubber Producers' Research Association and later as a lecturer. At Birmingham, in collaboration with Prof. M. Stacey, he directed a succession of research students engaged on the synthesis of deoxy sugars and on the structure and physical chemistry of nucleic acids. He has made notable contributions to the chemistry of anhydrous sugars and sugar phosphates. In 1951–52 he was associate professor at Pennsylvania State University with Prof. R. Pepinsky. In 1955 he was appointed reader in organic chemistry at Birkbeck College, where he has already built up a flourishing Department. At the present time his research interests are in conformational analysis and in reaction mechanisms in the carbohydrate group.

He takes a great deal of interest in extra-mural teaching for the Royal Institute of Chemistry and for the Society of Chemical Industry. He is a member of Council of the latter body. His great industry is shown by the fact that already he has more than a hundred papers to his credit, published mainly in the *Journal of the Chemical Society*. Mrs. Overend is a graduate chemist of the University of Birmingham and has shared in some of her husband's researches.

National Metallurgical Laboratory, Jamshedpur : Dr. B. R. Nijhawan

Dr. B. R. Nijhawan has been appointed director of the National Metallurgical Laboratory of India in succession to Dr. E. H. Bucknall. Dr. Nijhawan graduated in metallurgy from Banaras Hindu University in 1936 and after two years with the Tata Iron and Steel Co., Ltd., was awarded a Federal State Scholarship to conduct research work in Britain. He proceeded to the University of Sheffield, where, for the next four years, he did metallurgical research under the supervision of Prof. J. H. Andrew. After gaining his Ph.D. degree, Dr. Nijhawan was recalled to India as research officer in the Government Metallurgical Inspectorate at Tatanagar, in which capacity he worked for more than six years. Dr. Nijhawan is well acquainted with the work of the National Metallurgical Laboratory, for he has taken an active part in its affairs since 1948, when he became an assistant director. After five years in that post he was promoted deputy director, and since Dr. Bucknall's resignation about a year ago he has been acting director. In 1951, as United Nations Fellow, Dr. Nijhawan toured European research laboratories and metal production centres. In 1953 he toured the Commonwealth of Australia as Indian delegate to the fifth Empire Mining and Metallurgical Congress. Dr. Nijhawan is the author of numerous papers on a variety of metallurgical subjects. He is a fellow of the Institution of Metallurgists and of the National Institute of Sciences of India.

Wistar Institute of Anatomy and Biology : Dr. H. Koprowski

The appointment of Dr. Hilary Koprowski as director of the Wistar Institute of Anatomy and Biology, Philadelphia, is announced. Dr. Koprowski received his M.D. degree from the University of Warsaw in 1939. In 1940 he went to Brazil as a member of the staff of the Yellow Fever Research Service which was supported by the Rockefeller Foundation, and he remained there for six years. Since 1946 Dr. Koprowski has been assistant director

of the division of viral and rickettsial research of the Lederle Laboratories, American Cyanamid Company. In this position he has played an important part in the development of attenuated strains of virus suitable for use as virus vaccines. He is particularly well known in connexion with the development of the Flury strain of chick-embryo adapted rabies virus, which is now widely used as a vaccine against rabies. Dr. Koprowski was also the pioneer in preparing and testing attenuated strains of poliomyelitis virus and he has campaigned vigorously for the use of live avirulent virus as an immunizing agent against poliomyelitis. In addition, Dr. Koprowski has worked recently on the application of the technique of inducing immunological paralysis to the problem of the resistance of animals to experimental tumour grafts. He plans to continue his researches along similar lines in his new position.

Commonwealth Fund Fellowships

THE Committee of Award of the Commonwealth Fund Fellowships has made the following elections, among others, for 1957–58. *General Fellowships:* J. F. Adams, Trinity College, Cambridge (mathematics); B. J. Birch, Trinity College, Cambridge (mathematics); J. N. Bradley, Birmingham (chemistry); J. C. Clarke, King's College, Durham (nuclear engineering); Miss Jean La Fontaine, Newnham College, Cambridge (anthropology); J. G. Phillips, Liverpool (endocrinology); D. R. Sweetman, Birmingham (nuclear physics); R. D. Sykes, St. John's College, Cambridge (philosophy); A. M. Wetherell, Liverpool (physics); B. R. Wilson, Leicester and Leeds (sociology). *Home Civil Service Fellowships:* H. W. Evans, Ministry of Labour and National Service; Mrs. P. B. M. James, Board of Trade; D. N. Rhodes, Department of Scientific and Industrial Research; C. H. E. Warren, Ministry of Supply. *Oversea Civil Service Fellowships:* K. C. W. James, Nigeria (engineering); K. Sargent, Kenya (forestry).

Membership of the Nature Conservancy

Colonel H. Morrey Salmon and Prof. J. A. Steers, of the University of Cambridge, have been appointed members of the Nature Conservancy. The vacancies have arisen through the retirement of Sir William J. Pugh, who remains a member of the Scientific Policy Committee, and of Prof. V. C. Wynne Edwards, who remains a member of the Scottish Committee and the Scientific Policy Committee. Prof. F. W. Shotton, of the University of Birmingham, has joined the Committee for England in succession to Sir William Pugh. Prof. E. W. Knight-Jones, of University College, Swansea, and Prof. D. Williams, of the Imperial College of Science and Technology, London, have joined the Committee for Wales in succession to Mr. J. Challinor and Mr. E. H. Chater, who have retired from it. There has been no change in the composition of the Scottish Committee.

Institution of Chemical Engineers: Royal Charter

THE grant of a Royal Charter of Incorporation to the Institution of Chemical Engineers has been approved by H.M. the Queen. At the thirty-fifth annual corporate meeting of the Institution on April 30, the retiring president, Mr. John Oriel, also announced that H.R.H. Prince Philip has consented to become Royal Patron of the Institution. At the meeting the following officers were elected: *President*, Sir Hugh Beaver; *Vice-Presidents*, Dr. E. H. T. Hoblyn, G. U. Hopton, H. P. Weber and A. S. White; *Joint Hon. Secretaries*, F. E. Warner and R. C. Odams; *Hon. Treasurer*, F. A. Greene.

John Wiley and Sons, Inc.

IN 1807, Charles Wiley opened a modest business as a publisher–printer–bookseller in Reade Street, New York; from this venture grew the present firm of John Wiley and Sons, Inc., which is celebrating its 150th anniversary this year. To mark the occasion a luncheon was arranged in London on May 3 by Messrs. Chapman and Hall, which have been the British representatives of the American house since 1895; those present included Mr. E. P. Hamilton (chairman), a great-grandson of the founder, and Mr. W. Bradford Wiley (president), who represents the fifth generation of the family. In connexion with the celebration, Messrs. John Wiley have produced an illustrated survey of the history of the firm which is well worthy of the occasion. Faced with the problem of preparing such a record, the first difficulty arose from the fact that the founder did not keep any records; but it is known from advertisements which have survived that the earlier published books were mainly literary, Fenimore Cooper and Washington Irvine being among the authors. Charles Wiley was succeeded by his son John, who was joined by George Putnam, the partnership lasting until 1848. Technical books had been published during this period, but from the middle of the nineteenth century the firm turned more and more to scientific and technical publications. John Wiley's two sons entered the business in due course, and the firm received its present name.

The anniversary volume consists principally of chapters by various authors, each devoted to a particular topic and surveying briefly Messrs. Wiley's contributions to the literature of the subject: the list of subjects alone, covering both pure and applied science, illustrates the comprehensiveness of the firm's activities—and as the years went by, it is noteworthy that the appearance of new fields of interest were met by appropriate text-books and larger works. Of the authors who have been associated with Messrs. Wiley, it will be sufficient for the scientist to mention J. D. Dana, the second edition of whose "System of Mineralogy" was produced in 1844; Ellsworth Huntington, known for his work on human geography; L. E. Dickson, who wrote on the theory of equations; A. F. Holleman, author of "A Text-book of Organic Chemistry"; and Asa C. Chandler, author of "Animal Parasites and Human Disease". John Wiley and Sons have served science and technology well in the past, and can look to the future with confidence.

The Irish Naturalists' Journal

The Irish Naturalists' Journal is the only periodical published in Ireland which is devoted exclusively to natural history. This *Journal* has been published regularly in Belfast since 1925 and caters for a wide field of interests. It publishes articles on the fauna, flora and geology, records new to Ireland, and field notes on birds, fishes, insects and plants. Reports from various natural history societies are included at regular intervals. The current issue is a special Nature protection number, containing an article specially written by Michael O'Ruadhain on the position of Nature protection in Ireland in 1956 with an extensive and useful bibliography. Shorter notes

included in this issue discuss the breeding of shelduck at Magilligan, the status of the smew, the occurrence of a sea-horse off the coast of County Clare, and botanical notes. The *Journal* is published quarterly by a committee of naturalists under the editorship of Miss M. P. H. Kertland, the annual subscription being 10*s*. Copies may be obtained from E. L. Calvert, Plant Pathology Field Station, New Forge Lane, Belfast.

Use of the National Land Fund

In the Budget debate in the House of Commons on April 15, Mr. H. Dalton made a number of proposals regarding the National Land Fund, from which the Chancellor of the Exchequer is proposing to take £50 million. Mr. Dalton recapitulated the use which has been made of the Fund since it was created ten years ago to acquire properties which have been placed in the care of the National Trust and other suitable bodies; he urged that the Fund should be used on a much greater scale to prevent the destruction or spoiling of some of the better country and similar houses in Britain, and also wide areas of beautiful and often mountainous country, by placing them in the hands of some body which could be trusted to serve national as opposed to private interests. Specifically, he urged that the Fund should be used to provide the National Parks Commission with the finance it needs. The Chancellor agreed to study Mr. Dalton's suggestions, but observed that money for such purposes is in general best voted in Supply; in his view, it should be on the vote of a Minister and debated in the House of Commons.

Thames Basin Archæological Observers Group

In London, Middlesex, Hertfordshire and Essex a group of archæologists, largely amateurs, has been formed to examine deposits in the Thames Basin area and thereby to prevent archæological and geological knowledge from being lost irrevocably through quarrying, building operations and various civil engineering projects. Thus, gravels, 'peats', river terraces, cuttings and other deposits are being diligently examined, principally for Stone Age and Pleistocene remains. Members of the group have already begun sending details of finds, including Levallois flakes from near St. Albans, bones of a pachyderm from near West Hyde, a pagan Saxon split-socket spearhead from the Cheshunt area, and an Acheulean hand-axe of known provenance in the possession of a small boy at Croxley Green. Wherever possible, details of finds in private hands are being entered on cards. The group arranges lectures and outings for its members. Mr. A. D. Lacaille, author of the "Stone Age in Scotland" and an authority on the Stone Age in the Thames Valley area, has consented to be honorary adviser to the Thames Basin Archæological Observers Group, which has been affiliated to Group 10 of the Council for British Archæology. It is hoped that geologists, students of natural history and others will pass on information to the group's acting recorder, Francis Celoria, 519A Finchley Road, Hampstead, N.W.3.

British Conference on Automation and Computation

The rapid growth of the new industrial techniques known as automation, which also comprise computation, process control and data processing generally, and of the many persons likely to be affected by their application, has given rise to an urgent need for the establishment of some central organization to afford liaison between all the interested institutions. At the invitation of the Institution of Civil Engineers, the Institution of Mechanical Engineers and the Institution of Electrical Engineers, exploratory conferences were held on March 6 and April 16, as a result of which representatives of some twenty organizations with interests in the fields of automation and computation, including most of the major professional engineering and management institutes, approved proposals for closer collaboration, and agreed to recommend them to their Councils for adoption. The proposals, if accepted by the bodies concerned, will result in the setting up of a British Conference on Automation and Computation which will be organized in three groups of societies, having the following fields of interest: (*A*) the engineering applications of automation techniques; (*B*) the development and application of computers, automatic controls and programming techniques; (*C*) the sociological and economic aspects of automation and computation procedures. At the exploratory conferences there was unanimous agreement that the setting up of a new and all-embracing society to be concerned with automation is not required, but that great advantage to Britain would ensue from the measures of collaboration now proposed, it being fully recognized that, in the framework of automation, the importance of the human side is equal to, if not greater than, that of the purely technological aspects. All societies and institutions interested in the subject will be welcome to support the activities of the conference by applying for membership of the appropriate group or groups. Further information can be obtained from the Secretary, Institution of Electrical Engineers, Savoy Place, W.C.2.

Society of Indexers

A new Society of Indexers, to encourage the publication of indexes, not only to books and periodicals but also to documents and archives, to improve the standard of indexing and to secure some measure of uniformity in technique, was founded at an inaugural meeting at the National Book League on March 30. The Society is to set up a panel of indexers specializing in various fields, from which authors, editors, publishers and others may be furnished with suitable names on application. It hopes to issue occasional papers and notes on indexing, and also to act as an advisory body on the qualification and remuneration of indexers. Membership of the Society is open to all *bona fide* indexers, librarians, cataloguers, archivists and others interested in promoting its objects, on payment of an annual subscription of two guineas. Institutional membership is open to non-profit-making organizations (two guineas) and other bodies (minimum of four guineas). Further details and forms of application for membership can be obtained from the Hon. Secretary, the Society of Indexers, 4 Fitzroy Street, London, W.1.

National Museums of Southern Rhodesia

The annual report of the National Museums of Southern Rhodesia for 1955 records the activities of the National Museum at Bulawayo and the Queen Victoria Museum at Salisbury. The most important work during the year has been the preparation of plans for the new museum building at Bulawayo. The report also records that Lieut.-Colonel H. L.

Boultbee took up his appointment as keeper of the Queen Victoria Museum in November. He states that the existing building is entirely unsuitable for museum purposes and that the only possible solution is to rebuild. The problem is fully appreciated by the Trustees, and negotiations with the City of Salisbury for a site in the new Civic Centre are in progress.

Field Studies Council Courses

THE Field Studies Council is to hold a course on "Weather and Flight" at Preston Montford Field Centre, Montford Bridge, near Shrewsbury, during July 3–10. This course, which is to be directed by Dr. R. S. Scorer, lecturer in meteorology in the Imperial College of Science and Technology, London, is designed particularly for pilots of gliders and other aircraft to whom observation and interpretation of weather are of practical importance; but it should also be of interest and value to ornithologists, entomologists and others concerned with the effect of weather on animal flight. Elementary meteorology and aerodynamics will form the basis of the course, for which a knowledge of advanced mathematics is not necessary. The emphasis of the course is upon observation out of doors, and particular attention will be paid to weather photography and the recognition of clouds. It is hoped to arrange a visit to a gliding club where there will be opportunity to take to the air.

The Field Studies Council, in association with the Royal Meteorological Society, has also arranged a Short Vacation Course in Meteorology, to be held at Malham Tarn Field Centre, near Settle, Yorkshire, during August 21–28. The course will be directed by C. D. Ovey, lecturer in geography in the University of Cambridge, and by Dr. R. S. Scorer. The emphasis will be on practical aspects of meteorology, and previous experience is not essential. Forms of application and further particulars about the courses can be obtained from the Wardens of the respective Field Centres.

Fishery Research Training Grants

THE Development Commissioners, in association with the Ministry of Agriculture, Fisheries and Food and the Scottish Home Department, are to award two—or if there are sufficient applicants of exceptional merit three—postgraduate training grants in fishery research tenable from October. These training grants are intended to enable selected candidates to undergo a specified course of training to fit them for the investigation of problems in marine or freshwater science. The course will not normally enable the holder of an award to qualify at the same time for a higher degree, but the Commissioners would consider applications from candidates for permission to register for a higher degree in circumstances where this seems likely to be consistent with the requirements of the approved fishery research training programme. The training which students will receive should fit them for employment either in the Fishery Research Service of the Ministry of Agriculture, Fisheries and Food and the Scottish Home Department or in a marine or freshwater biological research institution. Candidates must be British subjects and graduates with honours in science or possess equivalent qualifications. Further details and forms of application, to be returned by May 27, can be obtained from the Secretary, Development Commission, 3 Dean's Yard, Westminster, London, S.W.1.

Zoological Nomenclature

THE International Commission on Zoological Nomenclature gives notice that as from September 29, 1957, it will start voting on the following cases involving the possible use of its plenary powers for the purposes specified. Full details were published on March 29 in the *Bulletin of Zoological Nomenclature* (13, Double-Part 2/3 and Part 4): (1) Viviparidae Gray (J. E.), 1847, validation and counter-proposal for suppression of *Viviparus* Montfort, 1810 (Cl. Gastropoda); (2) *mississippiensis* (emend. of *mississipiensis*), validation of, as specific name for North American alligator (Cl. Reptilia); (3) Muntiacinae Pocock, 1923, and Odobenidae Allen (J. A.), 1880, validation of for the barking deer and walrus respectively (Cl. Mammalia); (4) *Dictyoploca* Jordan, 1911, validation (Cl. Insecta, Order Lepidoptera); (5) *Staphylinus* Linnæus, 1758, designation of *Staphylinus erythropterus* (emend of *erytropterus*) Linnæus, 1758, as type species of (Cl. Insecta, Order Coleoptera); (6) *Anopheles* Meigen, 1818, designation of type species for (Cl. Insecta, Order Diptera); (7) *picta* Walckenaer, 1802 (*Aranea*) and *Theridium* (emend. of *Theridion*) Walckenaer, 1805, validation (Cl. Arachnida); (8) *Vespertilio murinus* Linnæus, 1758, type species of *Vespertilio* Linnæus, 1758, clarification of interpretation of (Cl. Mammalia); (9) *Toxorhynchites* Theobald, July 1901, validation (Cl. Insecta, Order Diptera); (10) *truncatula* Bruguière [1792] (*Bulla*), interpretation of and *umbilicata* Montagu, 1803 (*Bulla*) validation (Cl. Gastropoda). Comments should be sent as soon as possible and in duplicate to Francis Hemming, Secretary to the Commission, 28 Park Village East, Regent's Park, London, N.W.1.

National Institute of Agricultural Botany

A RECENT issue of the *Journal of the National Institute of Agricultural Botany* (7, No. 3; 1957) contains reports on trials of winter wheats, spring oats, spring barleys, first early potatoes, sugar beet, lucerne and winter cauliflower which demonstrate how carefully the varieties are studied before recommendations are made. The question of impurities in the wheat variety 'Yeoman' is discussed by A. F. Kelly, who concludes that during the period 1948–53 mutation of one or more characters has occurred, although out-pollination may be responsible for some of the variation. F. L. Squibbs describes the characters of 21 varieties of dwarf beans which have appeared in British catalogues between 1950 and 1953, and a key, including 28 varieties previously described, incorporates 48 types, with illustrations of the seeds of each. The long series of lucerne strain trials bring out clearly the fact that yield is influenced by season and management more than by variety. Nevertheless, two strains of the earlier type 'Chartrainvilliers' and 'Du Puits' showed consistent superiority in yield and agronomic behaviour over the other strains in these trials. The report records that a further edition of "Varieties of Potatoes and their Synonyms" has been prepared, and the typescript is available for reference in the library of the Institute.

Soils and Manures for Fruit

FOR profitable fruit-growing, the selection of the right type of soil is as essential as good management and proper manurial treatment. Knowledge of the basic nutrient requirements of fruit trees is relatively

recent, and extension of fruit-growing to new districts continues. The second edition of the Ministry of Agriculture Bulletin No. 107, by Prof. T. Wallace, now renamed "Soils and Manures for Fruit" (pp. iv+41+12 plates. London: H.M. Stationery Office, 1956. 3*s*. 6*d*. net), will therefore be welcomed both by the established and intending fruit-grower, as it brings together for the first time the results of the fruit soil surveys carried out in the inter-war years, and the accumulated experience of the manurial requirements of trees and soft fruits on different soils. For the new grower, information is provided both regarding the suitability of soils for fruit in general and the particular requirements of individual crops. Mineral nutrition is dealt with in some detail and advice given as to how symptoms of deficiency may be recognized and remedied. The two sections on manuring consider the subject on a wide basis, taking into account the many aspects of orchard practice, such as planting and cultural systems and time and method of application, as well as the special needs of each crop. Photographs illustrating symptoms of various mineral deficiencies and unthriftiness due to unsuitable soil conditions add considerably to the value of the bulletin.

The Imperial Forestry Institute, Oxford

The thirty-second annual report of the Imperial Forestry Institute for 1955–56 (pp. 28. Oxford: Holywell Press, Ltd., 1956) gives evidence of considerable activity in both forestry education and research and of the recognition it is receiving from other countries. One of the chief features of interest was the twelfth Congress of the International Union of Forest Research Organizations held at Oxford during July 6–14, 1956. Forty-one countries were represented by two hundred and thirty-seven delegates; in addition, five representatives of the Food and Agriculture Organization of the United Nations attended. For the first time in our history, Britain is now included among those countries in which scientific forestry is part of the administration of the State in the interests of its people and their posterity. Last May the French Director General of Eaux et Forêts and a party of his officers, on the invitation of the Forestry Commissioners, visited the New Forest and other areas in Britain. Under the auspices of the Institute, a study tour in western England and Scotland was arranged for a party of foresters from the Swedish State Forester Training School at Skinnskatteberg.

The number of students at the Institute attending the courses throughout the year was forty-eight, of which nineteen obtained the forestry degree. Some of the students were from the Commonwealth and Colonies. India was represented by three forest officers, and Pakistan and Ceylon by one each. Under arrangements made with the British Council, a professional forester from Finland, two students from Burma and two forest officers from Thailand spent the year at the Institute. A comprehensive tour for those taking courses was carried out in Sweden in addition to student's tours in Britain and France. It is of interest that the Institute and Forestry Department are taking an active part in the planting of hardwoods, so much neglected in England in the past, including the planting of twelve acres of mixed hardwoods and conifers in Wytham Woods. This primary work of regenerating the large areas of open and scrub woodland will continue for some years.

Research at the Forestry Research Institute, Dehra Dun, India

The systematic study of the strength properties of Indian woods was practically unknown until after the First World War and was commenced at the Dehra Dun Research Institute in 1921 in accordance with certain established standards then existing in the United States and Canada. Now some 156 species have been tested, and the results published in *Indian Forest Research*. Some further ten species are recorded in *Indian Forest Research*, 1, No. 3 (Office of Survey of India, Dehra Dun, 1956). The species dealt with are of considerable interest, consisting of species of the genera *Ougeinia*, *Chloroxylon*, *Cryptomeria*, *Altingia*, *Canarium*, *Myristica*, *Lophopetalum*, *Anisoptera*, *Cinnamomum* and *Mallotus*. The tests undertaken were of green and air-dried material and in kiln-dry condition.

The Indian Forest Bulletin, No. 197 (1956), on cellulose and paper, deals with laboratory experiments on the production of pulps from twisted chir pine (*Pinus longifolia*). This tree occurs in the Punjab, the United Provinces and Kashmir. Railway sleepers are made from it. In Kumaon in the United Provinces the tree has at times a twisted grain which renders it unfit for timber. This has been long known, such trees having no economic importance. The extent of forest covered by such trees is unknown. Owing to the waste entailed in such trees standing in the forest, it was considered desirable to make experiments at the Research Institute at Dehra Dun to investigate its suitability for wrapping paper, of which such enormous amounts are used in India. Since the twisted chir pine is long-fibred, the effect of the admixture of groundwood pulp and bagasse pulp to chir pulp on the strength properties of the resulting wrapping papers was also studied, the results being described in the Bulletin. The investigation has shown that twisted chir is useful fibrous raw material for the manufacture of wrapping paper. So a very unexpected use has been found for a previously useless and annoying member of the forest.

Comet Arend–Roland

Numerous observations of this comet have now been reported in *Circulars* of the International Astronomical Union and of the British Astronomical Association. It is clear that the comet has come up to expectations. It has proved a striking object in a dark sky, with a very bright small nucleus and a tail more than twenty degrees long. The comet was observed by a New Zealand amateur astronomer, Dr. J. G. Gow, on April 2, when it was of the second magnitude. It was also observed by the New Zealand and French Antarctic Expeditions. It was first seen from the United Kingdom on the evening of April 20. Observations by Mr. M. J. Hendrie and by Dr. R. L. Waterfield on April 21 agreed in indicating a brightness close to zero magnitude, as predicted. In addition to the ordinary tail, the comet showed an unusual extension, stretching for some thirteen degrees towards the Sun. This 'beard' included a bright long jet. The beard faded rapidly as the comet receded from the Sun. Spectrograms of the head of the comet obtained at the Hamburg and Haute Provence Observatories showed a very strong continuum, a strong CN band at 3883 A. and very strong sodium *D* lines.

Comet Arend–Roland was detected by Dr. J. D. Kraus at Ohio State University as a weak radio

source on March 10, using for this purpose a frequency of 28 Mc./s. Other radio observations have been made on the same frequency on later dates. The intensity received has fluctuated from day to day, attaining a maximum of 5×10^{-22} watts per square metre per cycle per second. The source of the radiation seemed to be in the tail of the comet. Radio radiation at a frequency of 600 Mc./s. was detected by Mr. Koeckelenbergh on April 9 at the Humain station of the Royal Observatory of Belgium. The comet is not expected to remain visible to the naked eye beyond the third week in May, and earlier in the month observation will be very difficult because of moonlight. The comet remains a circumpolar object for observers in Britain and it will be possible to follow it for some weeks with moderate telescopic aid.

Royal Institution: Officers

At the annual meeting of the members of the Royal Institution, which was held on May 1, with the president, Lord Brabazon, in the chair, the following officers were elected: *President*, Lord Brabazon of Tara; *Treasurer*, Mr. W. E. Schall; *Secretary*, Mr. S. Robson; *Managers*, Mr. J. F. Coales, Dr. A. Clow, Mr. E. R. Davies, Dr. P. Dunsheath, Sir Alfred Egerton, Prof. James Greig, Mrs. H. K. Hawkes, Prof. A. V. Hill, Brigadier H. E. Hopthrow, Mr. L. B. W. Jolley, Dr. A. R. Kagan, Dr. L. H. Lampitt, Mr. James Lawrie, Dr. H. Lowery, Prof. W. D. Wright; *Visitors*, Mr. W. W. Abson, Mr. H. E. Baker, Mr. F. G. Brown, Dr. F. H. Cotton, Sir Graham Cunningham, Captain H. L. Hitchins, Miss E. H. Jebens, Dr. L. A. Jordan, Mr. G. Parr, Mr. J. D. Peattie, the Hon. Philip E. H. Samuel, Mr. Neville Shepherd, Miss Daphne Sidebottom, Mr. W. R. Stevens, Dr. Norman Stuart.

Announcements

Dr. D. McKie, reader and head of the Department of the History and Philosophy of Science in University College, London, has been appointed Chevalier de la Légion d'Honneur.

The Duke of Northumberland has been appointed chairman of the Agricultural Research Council in succession to Lord Rothschild, who retires on June 30 after ten years service.

The Society of Chemical Industry has acquired new headquarters premises in London at 14 Belgrave Square, S.W.1.

The Challenger Society is prepared to make small grants for research in marine biology or oceanography at a recognized laboratory during the year June 1957–June 1958. Applications, accompanied by details of the proposed research, should reach the Hon. Secretary, Challenger Society, National Institute of Oceanography, Wormley, nr. Godalming, Surrey, not later than May 25, 1957.

The Halley Lecture on Astronomy and Terrestrial Magnetism for 1957 will be delivered by Dr. Walter Baade, of Mount Wilson and Palomar Observatories, in the lecture theatre of the Physical Chemistry Laboratory at the University of Oxford on May 16, at 5 p.m. The subject of the lecture will be "Galaxies and their Stellar Populations".

The Association of Applied Biologists has elected the following officers: Dr. W. P. K. Findlay (*president*); G. G. Samuel (*vice-president*); Dr. I. Thomas (*president-elect*); and *new members of Council* for 1957, P. Aitkenhead, Dr. M. T. Franklin, Dr. A. H. M. Kirby and M. E. Solomon.

The International Corresponding Club for Preventive and Social Medicine is organizing an international study group on "Current Epidemiological Research", to be held in Holland during September 1–6. Sessions will be devoted to cancer and mental illness, and one day will be given to a consideration of the evaluation of health needs and health services by epidemiological research methods. Further details can be obtained from Dr. J. Pemberton, Department of Social and Industrial Medicine, University of Sheffield.

The British Society of Rheology is organizing a conference on "Rheology of Disperse Systems", to be held at the University College of Swansea on September 19 and 20. Contributions are invited for this conference, and intending speakers are asked to write first to the conference secretary, Mr. C. C. Mill, Patra House, Randalls Road, Leatherhead, Surrey.

The International Society of Bioclimatology and Biometeorology will hold its first scientific congress in Vienna during September 23–27. There will be sessions on general, phytological, zoological, human and cosmic bioclimatology. Those interested in submitting papers or attending the congress should write to Dr. S. W. Tromp, Hofbrouckerlaan 54, Oegstgeest (Leiden), Holland.

The twelfth Symposium of the Society for Experimental Biology will be held in University College, London, during September 16–20, the subject being "The Biological Replication of Macromolecules". Non-members of the Society may attend on payment of a registration fee of two guineas. Further information can be obtained from the honorary symposium secretary, Dr. R. L. Billingham, Department of Zoology, University College, Gower Street, London, W.C.1.

A meeting of the Radiofrequency Spectroscopy Group is to be held at the University of Southampton during September 19–21. The symposium will be divided into three main sections on: (1) crystal structure analysis by electron resonance; (2) the investigation of free radicals by electron resonance; and (3) atomic and molecular standards of frequency and time. Further details can be obtained from Dr. D. J. E. Ingram, Radiofrequency Spectroscopy Symposium, The University, Southampton.

A conference on "Automatic Measurement of Quality in Process Plants", organized by the Society of Instrument Technology, will be held at the University College of Swansea during September 23–26. Residential accommodation will be available in the College hall of residence, Neuadd Gilbertson. The main object of the gathering is to provide an opportunity for the users and makers of automatic measuring equipment, and those concerned with research and developments in this field, to meet and discuss their work. Topics to be covered will include: *Chemical quality:* chromatography, mass-spectrography, *p*H measurement, spectroscopy and titration; and *Physical quality:* density, moisture content, refractive index, and viscosity and 'consistency'. It is hoped that the papers will ultimately be published, together with discussion submitted in writing after the conference. Inquiries should be addressed to the Secretary, Society of Instrument Technology, Ltd., 20c Queen Anne Street, London, W.1.

EAST AFRICAN TRYPANOSOMIASIS RESEARCH ORGANIZATION

REPORT FOR 1955–56

REMARKABLE advances in knowledge of trypanosomiasis and tsetse flies and in techniques for studying them are recorded in the latest report of the East African Trypanosomiasis Research Organization*. It is clear that the data provided by the new methods of study are throwing fresh light on old problems and revealing subjects for investigation. One of the difficulties of tsetse control has been to locate the fly. Some species are not attracted to man, such as *Glossina pallidipes*, and so have been difficult to capture, while among those that are easily caught only some 10 per cent join in the attack, and these are usually males. The use of traps has been reinvestigated and the 'Morris' trap has yielded important results. Fifteen traps caught many more *G. pallidipes* in a day than three boys in one hour. The proportion of females trapped was 80 per cent—as compared with 25 per cent caught by the boys—which is believed to be a near approximation to the percentage of females in a normal population. Furthermore, trap catches revealed a definite cycle of activity with a marked peak, which was not evident on hand-catching, and showed that the females attacked at different times of the day from the males. Investigations are being made into the design and use of traps, because siting and manipulation are proving to be skilled techniques.

Very interesting results are being provided by a study of tsetse blood meals. Nearly 1,500 blood meals from seven different species of tsetse have been examined, the most complete data being from *G. morsitans* and *G. swynnertoni*. Nearly half the blood meals in these species are now found to be from wart-hog; tsetse seldom feed from zebra and hartebeest, and rarely from impala even when these were abundant. *G. morsitans* will feed mainly on hippopotamus if this host is available, as will also *G. brevipalpis*. *G. palpalis* feeds mainly on reptiles, and nine meals tested from *G. longipennis* were all from rhinoceros. In the case of *G. pallidipes*, forty-three of fifty-two meals were from bush-buck and none was from the buffalo present. It is not clear whether the predominance of blood of the Suidae is due to preference on the part of the tsetse or to the ready availability of this host. In Zanzibar, *G. austeni* is found to feed only on bush-pig and domestic cattle in spite of the presence of small antelope, and elimination of the bush-pig, which is an agricultural pest, might result in eradication of the fly and the cattle trypanosomiasis it carries. Important practical conclusions may be expected to follow further studies in this field, because the rate at which the fly acquires infection must be related to its host preference, and this will influence understanding of epidemiology and the proper use of chemo-prophylaxis.

The results so far obtained may be affected by various factors requiring study, including the difficulty of capturing recently fed fly. New methods of capturing gorged male and female tsetse have been employed and in the first sample caught 86 per cent and 87 per cent, respectively, were found to have fed on Suidae, whereas previous methods gave 64 per cent for males alone. Another interesting finding is that when tsetse are maintained in the laboratory it is advantageous at intervals to change the sheep on which they are fed. The number of feeds taken is not affected by the change, but there is a considerable increase in larviposition and a reduction in abortions. The effect appears to be due to a reaction on the part of the host animal and it raises the possibility that in Nature there may be a limit to the number of tsetse which one animal host can support.

Observations made previously at Shinyanga indicated a ten-year cycle in the prevalence of *G. swynnertoni*. Similar cycles have now been shown to occur in *G. morsitans* and *G. pallidipes*, but they do not coincide with that of *G. swynnertoni* at Shinyanga, and the cycle noted in *G. pallidipes* seems to be of a different length.

Most knowledge concerning tsetses has been the result of catches of males, mainly those in the later stages of the hunger cycle. It has recently been noted that tsetse can be caught resting on trees at a distance between 3 and 15 ft. from the ground. A new technique is to mark flies with a paint fluorescing in ultra-violet light, which can be used for revealing their resting places. Tsetse reaction to atmospheric humidity is being studied, and it has been found that they are more active in drier atmospheres. It was held that they would, therefore, move until they reached an environment with a higher humidity. Studies of water-loss from adults, however, reveal a very efficient system of regulation, and when offered a choice the flies moved to drier air, particularly from very humid conditions. Field work in the past has been largely confined to the wet season, and the flies have been found in exposed but shaded habitats; dry-season studies may reveal a different type of resting place. Sense organs of adults and larvæ are being investigated, and the larva has been shown to possess a tactile organ anteriorly.

Research in relation to the trypanosomes has lagged behind that on tsetses, and the report indicates a number of interesting lines of investigation undertaken in this sphere. The whole cycle of development of the polymorphic trypanosomes is being studied. Experiments show that the metacyclic forms inoculated by the fly appear to develop directly into the blood forms without passing through any tissue phase. Trypanosomes were constantly shown by sub-inoculation to be present in the blood of an animal from a few minutes after intravenous inoculation of a large dose of metacyclic trypanosomes until they were detectable by microscopic examination on the fourth day, and this was corroborated by other experiments. It has been observed that on occasions *Trypanosoma rhodesiense* fails to complete development in vector flies after reaching the short crithidial stage which has been shown to occur between the proventriculus and the glands.

A possible source of error in fly-infection experiments has now been eliminated; newly infected flies can be maintained by feeding them on baboons which are refractory to all trypanosomes, and these feeds do not reduce the incidence of infection in the flies. The strain of *T. rhodesiense* isolated nearly twenty-two years ago and since then maintained in

* East Africa High Commission. East African Trypanosomiasis Research Organization Annual Report, 1955–56. Pp. 50. (Nairobi: Government Printer, 1956.) 7.50 Shs.

sheep by cyclical passage through *G. morsitans* has been proved still infective to man. Cyclically transmitted and syringe-passaged strains of trypanosomes have been shown to differ in their oxygen metabolism. These studies are being pursued in the hope of distinguishing between *T. rhodesiense* and *T. brucei* without recourse to human volunteers. The effect of cortisone on *T. rhodesiense* in rats has been investigated. After a heavy infecting dose, cortisone increased the initial parasitæmia, which declined about the twelfth day. The animals died more rapidly than controls, but death resulted from causes other than trypanosomiasis. In more lightly infected rats the incubation period was prolonged and parasitæmia remained at a lower level than in controls. Cortisone appears to have two effects: an interference with the acquired immunity in the host, and also an inhibiting effect on the trypanosome.

The earliest known epidemic of sleeping sickness occurred in 1374 in the Upper Niger and the disease spread thence to the French Congo and in 1885 had reached Stanley Pool. In 1900 it had invaded Lake Tanganyika and Lake Victoria. Its subsequent course in Uganda and Tanganyika is being studied. One interesting phenomenon is the change from the Gambian to the Rhodesian type of infection which occurred in Uganda between 1901 and 1940. The latter infection is now spreading slowly into Kenya, replacing *T. gambiense*. An animal reservoir of *T. rhodesiense* in wild game has been postulated by some authorities on epidemiological grounds. This has never been proved, and it is now being investigated by testing the infectivity to man of polymorphic trypanosomes collected from shot animals.

This brief résumé of the more important results of the year's work shows that the new methods of investigation are providing improved data which explain tsetse behaviour and will lead to better understanding of the fly and more efficient control. Studies of the trypanosome are not so far advanced, but gaps in knowledge of their development are being filled and methods are being investigated for differentiating trypanosomes, particularly the polymorphic species. These are achievements on which the Director and his staff are to be congratulated.

T. H. DAVEY

CARNEGIE UNITED KINGDOM TRUST

REPORT FOR 1956

THE forty-third annual report* of the Carnegie United Kingdom Trust for 1956 refers to the disappointment of hopes entertained a year ago of some response by the Government to the Museums Association's efforts to attract assistance for the smaller museums of Britain. The Association did not accept the Government's view that there were insufficient grounds for providing financial assistance from the Exchequer and that museums and galleries should look to the local authorities. The Trust reiterates the hope that the Association will be able to convince the Government of its responsibility in regard to saving a vital national heritage. The Trust is convinced that the mere location of a specimen of historical significance in any field of science or technology or of a work of art does not determine its value or importance in the cultural life of the nation, nor, in spite of the enlightened action of Durham County Council in accepting responsibility for the Bowes Museum at Barnard Castle, does it suggest that it is the normal function of a local education authority to acquire and administer a museum. Sir George Dyson, the chairman of the Trust, was even more forthright on this question of museums in asking, at a meeting of the Trust in Dunfermline on March 8, for a comprehensive and sympathetic examination of all relevant factors and for a broad national policy supported by adequate resources. During the year, twenty-three museums took advantage of the report service under the Trust's present policy to obtain grants totalling £4,349, while eleven museums completed their schemes of reorganization with the aid of earlier grants. Travel grants enabled thirteen junior members of the museum profession to attend the Museums Association Conference in Holland.

The Trust's largest new commitment is a policy of making grants-in-aid to re-equip pre-war village halls, under which an allocation of £100,000 is expected to be distributed during the present quinquennium. For approved schemes, grants up to three-quarters of the cost will be made to villages of less than 500 people, and up to half the cost for larger villages up to 1,000 people, with a limit of £200 for any one scheme and assurance of a matching local contribution. A sum of £20,000 has been set aside for distribution in grants towards the cost of building new halls when a scheme for Eire, where public funds for this purpose are not available to the same extent, has been approved. Grants were made during the year towards the installation of film projectors for Fair Isle and the island of Foula and a sum of £2,500 has been set aside for projector grants to be distributed in consultation with the Highlands and Islands Film Guild.

A grant of £1,000 was promised towards a survey of rural industries in Northern Ireland, and the inquiry into the problems of families with handicapped children, approved last year, has now begun with teams in Shropshire, Sheffield and Glasgow. The Glasgow Society of Social Service was promised a grant of £8,000 for a small building to serve as a branch office in Drumchapel and towards administration for five years, and a further commitment of up to £8,000 was accepted to assist the National Association for the Paralysed's scheme to demonstrate the service which the State might provide for such young people. A supplementary grant of £6,500 was made to the Brentwood Recuperative Centre for Young Mothers, and another supplementary grant of £2,000 to the Family Discussion Bureau has enabled the Bureau to develop into an organization for helping those in difficulty with family relationships. The Trust's only financial interest in the Family Service Units during 1956, apart from a final grant to the research project, was in the training of social workers in this technique.

In education the Trust has been considering a policy of grants-in-aid of amateurs interested in those branches of science best studied in the countryside, and hopes to prepare a scheme which will take account of the local, regional and national societies for natural history and archæology to which amateur scientists belong. Promising progress is reported with planning a scheme for one of the national

* Carnegie United Kingdom Trust. 43rd Annual Report, 1956. Pp. viii+53. (Dunfermline: Carnegie United Kingdom Trust, 1957.)

forest parks in Scotland, which will enable the Trust to make some contribution to its amenity so that more people may be encouraged to discover, enjoy and understand the benefits and privileges of such an area. A very encouraging report was received from the London School of Economics on the second year of the one-year course in applied social studies.

HEALTH OF SCHOOL CHILDREN*

STEADY improvement in the health of school children in Britain is recorded in the report of the Chief Medical Officer of the Ministry of Education for 1954 and 1955. In 1955, for example, only 1·46 per cent of school children were considered to be in poor physical condition compared with 2·55 per cent as recently as 1952. In 1954, 21,000 London children were weighed and measured, and it was found that, since 1949, boys of all ages had gained on the average 0·59 in. in height and 3·3 lb. in weight, while the girls had gained 0·39 in. in height and 2·2 lb. in weight; the marked differences between the measurements of children in different districts of London noted in earlier surveys had "largely disappeared".

In Sheffield, on the other hand, there was still a progressive diminution in the heights and weights of boys and girls from "good" to "medium", and from "medium" to "poor", districts.

A 20 per cent sample of boys and girls of all age-groups in two contrasting areas in Manchester was specially examined in 1955, and it was discovered that those from a good residential area had a higher hæmoglobin-level than those from a poor area where housing was substandard. There is evidence that children who nowadays are considered to be of poor condition are, in fact, heavier and taller than their predecessors of 25–30 years ago. In Liverpool, for example, the average weight of 12-year-old boys of poor physical condition was 78·1 lb. in the years 1953–55 compared with 70·7 lb. in the period 1925–27; for 8-year-old boys the average weights were 55 lb. and 50·9 lb., and for 5-year-old boys 41 lb. and 40·3 lb. The figures for the girls were broadly similar. Another interesting finding in Liverpool was that the average weights of 8- and 12-year-old boys and girls considered to be of good physical state in 1925–27 were less than those of boys and girls of similar age but considered to be of poor physical condition in 1953–55. For the overwhelming majority of children, under-nutrition is no longer a problem.

Considerable attention was given to children with defective hearing. Audiometry is being used increasingly, and the pure-tone instrument is displacing the gramophone and audiometer in aural examinations. It is, however, exceptional for school children tested with an audiometer to be found for the first time with hearing so defective that they require education in a special school. In view of this, some doctors are doubtful of the value of the routine audiometric examination of children in age-groups and are considering reserving this form of examination for children with speech defect, for those with a history of ear disease, or for those who are not making satisfactory educational progress. Other doctors are of the opinion that audiometry has been used for too short a period to come to firm conclusions about how it should be used by the school health service, and that its main purpose may be the detection not of children in need of special educational treatment but of those with slight deafness who may be improved by medical or surgical treatment.

About half a million school children with defective vision, including squint, were dealt with in 1955. Special investigations have shown that about 3 per cent of 5-year-old children require spectacles, and the Chief Medical Officer recommends that the vision of children should be tested as soon as possible after they first enter school.

The decrease in juvenile rheumatism has been remarkable and is reflected in the reduction in the number of children with rheumatic heart disease in special schools. There are still, however, local fluctuations in prevalence; from experience in areas where the disease is compulsorily notifiable it is probable that in England and Wales there are about 2,000 new cases a year, only a small minority of whom are left with a permanently damaged heart.

Bed-wetting among school children has interested a number of school doctors for many years and in a few areas special clinics are held for them. It has been found that about 2 per cent of 12- to 13-year-old children still wet the bed at night. Apart from its social consequences, bed-wetting is distressing to children: they and their parents need all the help and encouragement that the school health service can give.

For the first time in the history of the school dental service, the total equivalent of whole-time dentists employed in it exceeded 1,000; at least twice that number is required for a complete service.

There were more than 130,000 fewer verminous children in 1955 than in 1950; even so, it is deplorable that 267,681 boys and girls were infested in 1955. In some areas only a handful of children were affected, whereas in others 15 per cent or more were involved. This is, essentially, a family problem.

The mortality of children continued to decline. In 1955, 2,753 children aged 5–14 years died; in 1938 the number was 9,047. In the past few years there has been a spectacular reduction in the number of deaths from some of the diseases that used to kill a great many children. Compared with 1938, for example, the number of children aged 5–14 years who died in 1955 from respiratory tuberculosis fell from 277 to 11, from other forms of tuberculosis from 693 to 43, and for diphtheria from 1,733 to 5. In grim contrast, however, are the figures showing the number of children dying as the result of accidents: in 1955, 404 died in motor-vehicle accidents and 485 in other accidents. Almost twice as many children aged 5–14 years now die annually from violence as die from all the infectious and respiratory diseases put together. To these figures must be added those for children under 5 years of age: in 1955, 209 died in motor-vehicle accidents and 879 in other accidents. Since accidents are preventable, it is deplorable that, in 1955, 2,000 boys and girls of less than 15 years of age died from this cause.

A new factor with which school medical officers have had to contend is the effect of television on child health. Several ophthalmologists reported upon the number of children attending eye clinics complaining of headaches. Although their vision was described as normal, investigation showed that they had been watching television when sitting on the floor, looking at the screen from an angle and sitting much too near the screen.

* The Health of the School Child: Report of the Chief Medical Officer of the Ministry of Education for the years 1954 and 1955. Pp. 187. (London: H.M. Stationery Office, 1956.) 6s. net.

To combat television headache it is recommended that "children should sit not less than 6 feet away from the screen, which should be a little above eye level, and as nearly as possible directly in front. A low light should be kept on, placed behind, or to the side of the viewers, to reduce the glare produced which is so tiring to the eyes".

THE MAGNETIC MOMENT OF THE NEUTRON

A NEW measurement of the magnetic moment of the neutron to a greater precision than before has recently been performed by V. W. Cohen, N. R. Corngold and N. F. Ramsey (*Phys. Rev.*, **104**, 283; 1956). Of the simpler nuclei and nucleons, the neutron is the one the magnetic moment of which has been measured with least precision. The general method used in the past by Bloch and co-workers employed the reorientation of the moments in a beam of polarized neutrons by an alternating magnetic field in resonance with the Larmor frequency of precession of the neutrons in a superimposed uniform magnetic field, but the accuracy was limited by the degree of polarization of the neutrons attainable by transmission through magnetized iron, the low neutron flux and the short path of the neutrons in the magnetic field.

In 1950, N. F. Ramsey showed (*Phys. Rev.*, **78**, 695) that the separated oscillatory field method of observation of resonance in a beam of magnetic particles produces a very narrow resonance line, thus permitting a precise measurement of the position of its centre, and in the following year D. J. Hughes and M. T. Burgy (*Phys. Rev.*, **81**, 498; 1951) discovered that neutrons reflected from cobalt mirrors magnetized to saturation are polarized to well over 90 per cent. These new developments have been incorporated in Cohen, Corngold and Ramsey's apparatus. A beam of slow neutrons obtained from the Brookhaven National Laboratory reactor was polarized by reflexion from a magnetized cobalt mirror and then reflected from a similar mirror used as an analyser. Between the two mirrors the neutrons pass through a region of uniform magnetic field where they may be depolarized by a resonant radio-frequency magnetic field, thus resulting in a drop in intensity of the neutrons reflected from the second mirror. The resonant frequency for depolarization is compared with the proton moment resonant frequency in the same transition region. For high resolution of the neutron resonance the path-length of the neutrons in the uniform magnetic field was made 110 cm.

Full details of the apparatus together with the experimental procedure and the results obtained are given. The measured ratio of neutron and proton resonant frequencies was $\nu_n/\nu_p = 0{\cdot}685057 \pm 0{\cdot}000017$, which may be compared with the last published value by Bloch of $0{\cdot}685001 \pm 0{\cdot}000030$. This leads to a value for the neutron magnetic moment of $\mu_n = -1{\cdot}913148 \pm 0{\cdot}000066$ nuclear magnetons. It is clear from the discussion that the neutron resonance measurement is more precise than that for the proton; some indication is also given of how, with improvement of technique, the ratio of neutron to proton moment may eventually be measured with an accuracy better than one part in a million.

MICROCLIMATE OF THE AFRICAN SAVANNA

THE literature on the climate of the lowest layers of the atmosphere in the tropical grassland regions is small. A notable contribution has, however, been made in the publication of the report "Exploration du Parc National de la Garamba"* by A. Noirfalise, of the Institut des Parcs Nationaux du Congo Belge. The area described lies in the extreme north-east of the Belgian Congo in latitude 4° N. on the border of the Sudan. It is in the savanna country of extensive grasslands varied by clumps of bush and scattered trees, with forests of larger trees along the river valleys. The paper describes first the macro-climate. The months from December to February constitute the dry hot season. There are rainfall maxima in May and August as the sun passes over, but the intervening dip in the rainfall variation is not very pronounced. In the dry season, temperature in the screen rises to 35° C. by day and falls to 15° C. at night, while in the cloudy rainy season the corresponding temperatures are 23° C. and 17° C. The relative humidity falls below 30 per cent at midday in the dry season, but to only about 60 per cent in the wet season. During the night it is more than 80 per cent throughout the year.

The most interesting part of the book deals with the microclimate of the great grasslands. In the first half of the rainy season when the grass has a height of 40–90 cm. the presence of the grass makes little difference to the temperature of the surface under the midday sun. The temperature at midday increases slowly downwards to about 5 cm. above the soil where the temperature is about 2 deg. C. above screen temperature. Between 5 cm. and the surface, temperature rises by about 10 deg. C. to give surface maxima of about 42° C. This is the same as the temperature reached by a grass-covered surface on a clear midsummer day in England. As the rainy season goes on, the grass grows more thickly and exercises a pronounced shading effect on the soil. This is illustrated by comparative curves of the vertical distribution of temperature over a bare and a grassy surface on a clear day in August 1952. Over the bare surface the distribution was as described before, with a surface maximum of 45° C. On the other hand, over the surface covered by thick grass the maximum temperature, 32° C., occurred at 10 cm. above the surface and the surface temperature was only about 27° C. There are large patches, ancient termitiaries now levelled, of bare soil in the savanna and the extremely high temperature which they reach tends to prevent the growth of grass over them. The thick grass of the rainy season has also a strong sheltering effect on the surface during rainfall, as the catch of a gauge at 20 cm. is reduced by some 60 per cent from that of a gauge clear of grass.

The paper also describes the microclimate under clumps of shrubs and trees in the savanna and in the forests which still exist along the rivers. The vegetation produces a smoothing of the diurnal variation of temperature in proportion to its density. Under the dense riverside forests there is very little variation indeed.

* Institut des Parcs Nationaux du Congo Belge. Exploration du Parc National de la Garamba. Fascicule 6: Le Milieu Climatique. Par Albert Noirfalise. Pp. 75. (Bruxelles: Institut des Parcs Nationaux du Congo Belge, 1956.)

THE QUESTION OF CORRELATION BETWEEN PHOTONS IN COHERENT BEAMS OF LIGHT

By Dr. PETER FELLGETT
The Observatories, Madingley Road, Cambridge

IT seems appropriate to begin with two general remarks. In the first place, an elementary calculation shows, as has been pointed out by Hanbury Brown and Twiss[1] and by Purcell[2], that the experiments of Brannen and Ferguson[3] and of Adam, Jánossy and Varga[4] lacked the sensitivity required to detect the correlation claimed to have been observed by Hanbury Brown and Twiss[5,6]; consequently the negative results do not conflict with the reality of the effect observed. Secondly, photon correlations of the kind involved are well known in the theory of fluctuation of radiation[7].

Historically, Hanbury Brown and Twiss's experiment arose from the desire for very high angular resolution in radio astronomy at a time when it was supposed that the bright discrete radio sources were of stellar size. In all kinds of radio (and indeed visual) telescope, angular resolution is obtained essentially by measuring the degree of coherence of the illumination from the source as a function of distance in the approximate plane of the wave-fronts. The angular brightness distribution is then the Fourier transform of this coherence. High resolution demands a knowledge of coherence over a large number of wave-lengths.

Hanbury Brown and Twiss pointed out[8] that if the radio-frequency fields at two antennæ are coherent, there will also be coherence between rectified 'video' signals of limited band-width derived from the two antennæ, and that in this way coherence could be investigated over much longer base-lines (much greater than 1 km.) than can conveniently be done by ordinary radio-frequency interferometry. This method having served its purpose of confirming[8] that the discrete radio sources in question were not in fact of very small angular subtense, it has since been little used in radio astronomy because its signal-to-noise relations make it suitable only for the most intense sources.

They also pointed out that inasmuch as the antennæ are used only as energy detectors without invoking their phase-sensitive properties, the same method could in principle succeed when the antennæ are replaced by photocells and visible radiation is observed; the required correlation is, however, masked in this case by a large amount of 'shot' noise which may be ascribed to the random rate of arrival of photons. Thus the Hanbury Brown and Twiss experiment[5,6], like that of Forrester, Gudmundsen and Johnson[10], belongs to the class in which an effect dependent on the 'wave' properties of light is observed in circumstances where the 'particle' properties predominate, and therefore a refined experimental method is necessary to detect the effect sought for. As Gabor has pointed out[11], wave properties are predominant when there are on average many photons per Bose cell, and particle properties when few cells are occupied by more than one photon.

The presence of correlation between the emission at two photocells can readily be understood in a semi-classical way. The square of the electric vector ascribed to a light beam varies in a random manner, and it is assumed that the probability of emission of a photoelectron is proportional to this quantity. If therefore in some time interval t an unusually large (say) number of electrons is emitted by one cell, a presumption is created that the mean square electric vector at this cell has been unusually large. If a second cell is subject to illumination coherent with that at the first, the same presumption applies to the second cell and hence the probability is enhanced that an unusually large number of electrons is emitted by this cell in the interval t.

This point of view illustrates that correlation may arise in an elementary way due to accidental fluctuations in the brightness of the source, or in the refraction of the air in the light-path ('seeing'), as well as in a more fundamental way from quantum effects. Hanbury Brown and Twiss have not perhaps completely excluded the possibility of such elementary effects in their experiments, although the case for considering their observed correlation to be fundamental is a strong one. The proposed astronomical application of their work would not be vitiated by the presence of non-fundamental correlation of some kinds.

Hanbury Brown and Twiss base their formulæ on the assumption, which will be referred to here as the 'semi-classical assumption', that photons 'arrive' at random, subject to the probability of their arrival being proportional to the square of an electric vector which itself has a Gaussian probability distribution of amplitude. This assumption is a natural one to make when the question is approached from a radio point of view, and it is known to be very successful in predicting mean behaviour; but I wish to point out that it is inadequate to predict fluctuations in general, and that in certain cases it apparently conflicts with arguments of a thermodynamic nature. What, in my opinion, is in question in the Hanbury Brown and Twiss experiment is not the reality of the effect, but the magnitude of the effect to be expected on theoretical grounds.

To show the inadequacy of the semi-classical assumption by itself, it is only necessary to point out that an identical assumption is equally successful in predicting the mean behaviour of electrons, but that the fluctuation-level of an assembly of fermions differs from that of an assembly of bosons. It may also be remembered that the electric vector is not an observable in optics, and that photons are not identifiable entities which can be observed travelling from source to receiver; semi-classical ideas, in fact, do not include the totality of our knowledge about the properties of radiation, and there is precedent for a more subtle theory being needed to predict fluctuations than suffices for mean values. Purcell[2] uses semi-classical methods with reserve, and in particular by saying that we would not be entitled to treat the wave function as a classical field in the case of electrons, he implies that justification is required for so treating it in the case of photons; we must ask in

what way both cases differ from that of 'classical' distinguishable particles associated with a probability wave.

The usual formula[7] for the fluctuation in the density n of photons in a temperature enclosure is:

$$\overline{\Delta n^2} = n\left(1 + \frac{n}{N}\right) \quad (1)$$

where $N = 8\pi\nu^2/c^3$ is the density of Bose distinguishability cells, c is velocity of light and ν is wave frequency. The first term $\overline{\Delta n^2} = n$ can be regarded as classical 'particle' noise, and the second term $\overline{\Delta n^2} = n^2/N$ can be interpreted either as classical 'wave' noise or as a statistical tendency of bosons to bunch together. Lewis[11] used this result to derive the fluctuation in the number m of photons absorbed by a black body in an enclosure, and found:

$$\overline{\Delta m^2} = m\left(1 + \frac{n}{N}\right) \quad (2)$$

Using the Einstein–Fowler formula[12]:

$$\overline{\Delta E^2} = kT^2\frac{\partial E}{\partial T} \quad (3)$$

for the fluctuation in the energy E of a body at temperature T, Clark Jones[14] and Fellgett[15] found the corresponding fluctuation for the number m of photons absorbed by a body of emissivity ε in an enclosure to be:

$$\overline{\Delta m^2} = \frac{2\pi\varepsilon A}{c^2}\frac{\nu^2}{(\exp(h\nu/kT)-1)}\left(1 + \frac{n}{N}\right) = m\left(1 + \frac{n}{N}\right) \quad (4)$$

where k is a Boltzmann constant, h is a Planck constant, A is area of a body.

For a black body, this result agrees with equation 2. On the semi-classical assumption that the photons absorbed in the general case are a randomly-selected fraction ε of a stream obeying equation 2, one obtains:

$$\overline{\Delta m^2} = m\left(1 + \frac{\varepsilon n}{N}\right) \quad (4a)$$

which differs from equation 4 unless $\varepsilon = 1$. If equation 4 is not valid, then unless there is an undetected mistake in the arguments used to derive this equation it follows that equation 3 is also not obeyed. By connecting a thermo-junction to a grey body which exchanges heat with its surroundings partly by radiation, it would then be possible to obtain available energy from a constant-temperature enclosure at a rate of the order of kT per unit bandwidth. Whether this is regarded as impossible is perhaps a matter of point of view; but it appears physically very unpalatable and would, of course, raise the question why equation 3 should fail in this particular instance.

In view of these difficulties, it seems that the formulæ purporting to predict fluctuations outside a cavity cannot be considered to be well founded. (This does not, of course, exclude the possibility that they may eventually prove correct.) Elementary methods may not be adequate to solve the problem, but one would guess that an adequate quantum-mechanical treatment has been, or could be, made. If this is so, it would be of service if attention could be directed to the result, as it does not appear to be well known in a form suitable for applications, and apart from its intrinsic interest the matter is of some importance in connexion with the noise-level of radiation detectors.

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INFRA-SLOW RHYTHMIC OSCILLATIONS OF THE STEADY POTENTIAL OF THE CEREBRAL CORTEX

By N. A. ALADJALOVA

Institute of Biophysics, Academy of Science of the U.S.S.R., Moscow

STEADY potential differences can be observed between every two of several cerebral cortical loci and is found to be in some correlation with the electrical activity of the cortical neurones[1]. The steady potential does not remain quite constant, depending upon the condition of the cortex[2], and it is referred to as quasi-constant.

We have shown previously[3] that the value of the steady potential of the cerebral cortex in certain conditions suffers continuous slow periodic oscillations. Two general rhythms were observed: the period of one is equal to 7–9 sec. and the amplitude to 0·2–1 mV. (Fig. 1); corresponding parameters of the other are: 1–1·5 min. and 1–2 mV. (Fig. 2). According to this, the frequencies of the steady potential variations are: 6–8 cycles per min. and 0·5–2 cycles per min. In certain cases intermediate frequencies may also be observed. We denoted these rhythms as 'infra-slow' in order to distinguish them from the 'slow wave' of the electrocorticogram.

Eighty-four unanæsthetized rabbits with implanted electrodes were examined. The electrodes generally used were silver plates 4 mm. in diameter and about 6 mm. between their centres. Four electrodes were implanted on the surface of each hemisphere, two in the frontal and two in the occipital area.

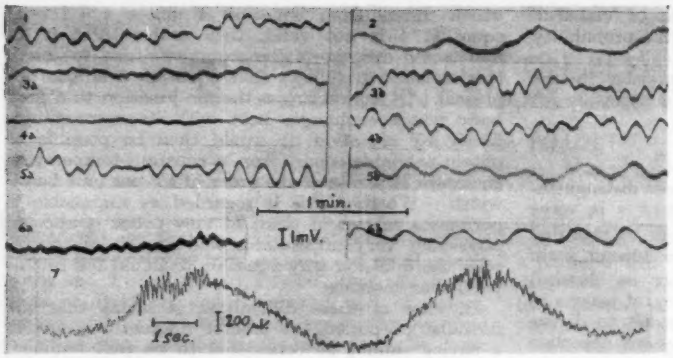

Fig. 1. The infra-slow rhythms: 1, 8 c./min. in motor cortex; 2, 1·7 c./min. in striate cortex; 3 *a*,*b*, before and after strychnine poisoning; 4 *a*,*b*, before and after a prolonged irritation of the region of hypothalamus; 5 *a*,*b*, before and in two hours after the injection of luminal; 6a, from the superficial layer of the sensory cortex, and *b*, from the depth 1·2 mm. (recorded by means of non-polarizable microelectrodes); 7, the speed of record and amplification is increased; the bursts are correlated with the rising phase of the infra-slow wave. Bipolar electrodes were used

In most cases the infra-slow rhythms were observed only in one or two areas of the cortex. While the 7–9 c./min. rhythm was noticed, for example, at the frontal area of one hemisphere, the 1–2 c./min. rhythm could be recorded from the occipital area of one of the hemispheres. In some cases only one rhythm was observed. The parameters of the infra-slow waves in both hemispheres (two-channel record) were not identical and their phases did not coincide.

It should be noticed that the patterns of the infra-slow waves were not always regular and distinctive. In these cases the regularity, the frequency and the amplitude of the infra-slow oscillations could be increased by certain external influences. The following intensifying factors were used: (1) metabolic disturbance[3,4], such as poisoning, or a prolonged asphyxia, repeated several times[3], and others; (2) prolonged irritation of some subcortical structures; (3) prolonged afferent stimulation (illumination of retina by flickering light, stimulation of n. sciatic, n. vagus).

Fig. 3 *a*, *b* illustrates the increasing of the frequency and amplitude of infra-slow rhythmical potential variations resulting from injection of strychnine. Instead of the irregular 5 c./min. rhythm (*a*), the 11 c./min. rhythm appeared (*b*). In this case a subcutaneous injection (0·4 mgm. per kgm.) was given three times during a week.

The records taken from the frontal area (Fig. 4 *a*, *b*) show that the regular infra-slow 8 c./min. rhythm can be obtained after a prolonged (one week) mechanical irritation of one region of the hypothalamus by the nichrome needle of about 0·3 mm. in diameter. The insertion of the needle only to the lateral nuclei of the thalamus does not produce such an effect.

In most cases the prolonged influence was necessary to obtain the regular rhythm increased in frequency. For example, brief asphyxia on one occasion changes the patterns of the electrocorticogram but does not affect the infra-slow waves. When it is repeated several times, asphyxia produces the regular infra-slow oscillations with great amplitude which are maintained for a long time after cessation of asphyxia.

The frequency and amplitude of infra-slow potential variations may be decreased in experiments by several kinds of external influences. (1) Complete disappearance of the infra-slow rhythm was observed during a deep ether anæsthesia. (2) The infra-slow rhythm became invisible after a strong electrical stimulation of the cerebral cortex[3]; it did not appear for 20–30 min. after the spontaneous activity of the cortex had become normal. (3) The infra-slow rhythms of decreased frequency and amplitude were observed during luminal sleep (Fig. 5 *a*, *b*). In two hours after subcutaneous injection of luminal (100 mgm. per kgm.) the frequency had decreased from 8 c./min. (*a*) to 3 c./min. (*b*).

The parameters of infra-slow rhythms vary not only in different areas of the cortex, but also in different layers of the cortex. The infra-slow waves have been analysed throughout measured depths in the cortex by means of non-polarizable microelectrodes[5] in rabbits immobilized by *d*-tubocurarine. In most cases the frequency was higher in the superficial layers of the sensory cortex (I–IV layers) (Fig. 6 *a*) than in deep-lying layers (V–VI) (Fig. 6 *b*).

There is a relationship between the phase of the infra-slow wave of the steady potential and the patterns of the electrocorticogram[3], especially when spindle bursts appear. The intense burst activity takes place in the moment when the front (rostral) end of the hemisphere is negative relative to the back (caudal) end. This is illustrated by the records of Fig. 7; amplification having been increased, the fast electrical activity superposed upon the infra-slow wave is seen.

Nevertheless, we have encountered many situations in which there has been no correlation between the observed steady potential wave and the patterns of the electrocorticogram. We are sceptical of any simple relation between steady potential state and the activity of neurones.

In order to examine the relationship between the infra-slow rhythms and the excitability of the cortex, some experiments were carried out with simultaneous determination of a cortical response to afferent stimulation[3]. As a result of the prolonged flickering illumination of the retina, the regularity of evoked potentials in striated cortex is periodically replaced by the disturbing rhythm of the response potentials. Instead of a response reaction to each flash, the potential is being evoked only by every second flash. This disturbance was found[6] to be related to decrease of cortical excitability. The infra-slow 1–2 c./min. rhythm tends to appear simultaneously with the appearance of such periodical changes in the regularity of evoked response. The period of disturbance of evoked rhythm was associated with an increase in the negativity of the striated area.

From the evidence presented here it is suggested that the events of the excitability change are associated in certain cases with infra-slow rhythmical change of the steady potential of the cerebral cortex. We consider these phenomena to be connected through a reaction complex that is probably chemically coupled. Many other aspects of the infra-slow rhythmical potential change also indicate that a

metabolic mechanism should be considered. However, brief changes of metabolism of the cortex do not affect infra-slow rhythm although they influence the patterns of the electrocorticogram (the case of short asphyxia). In order to change the infra-slow oscillations it is necessary to use a prolonged stimulus and to affect the state of subcortical structures (by a direct or indirect route). While there is no direct evidence that the infra-slow rhythmic changes of the steady potential of the cortex are partly associated with the functional state of the subcortical structures, this view is in accord with the observations presented above.

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PREPARATION FROM BAKER'S YEAST OF CRYSTALLINE CYTOCHROME b_2 HAVING NO LACTIC DEHYDROGENASE ACTIVITY

By JINPEI YAMASHITA, TANEAKI HIGASHI, TATEO YAMANAKA, MITSUHIRO NOZAKI, HIROSHI MIZUSHIMA, HIROSHI MATSUBARA, TAKEKAZU HORIO and PROF. KAZUO OKUNUKI

Department of Biology, University of Osaka

THE first solubilization of cytochrome *b* was reported from baker's yeast by E. Yakushiji and T. Mori[1]. On re-examination, their method with slight modification was found suitable for the extraction of cytochrome *c* and cytochrome b_2 without lactic dehydrogenase, but not cytochrome *b*, which remained tightly bound to the cellular particles. Their work was therefore regarded as the first detection and partial purification of cytochrome b_2 without lactic dehydrogenase. The cytochrome b_2 obtained by us showed absorption bands at 557 mμ and 528 mμ when it was reduced by dithionite. The cytochrome with no enzyme activity was expressed as cytochrome b_3, and the cytochrome with activity as yeast lactic dehydrogenase. We have already reported the crystallization of cytochrome *c* from baker's yeast[2]. This communication is concerned with the isolation and crystallization of cytochrome b_2 from the same source.

5 kgm. of pressed baker's yeast (Oriental Yeast Co., Ltd., Japan) was washed with a large amount of tap water, kneaded with 500 ml. of ethyl acetate and made fluid, and allowed to stand for 1 hr. at room temperature (10–15° C.). To the liquid was added 5 l. of tap water, and extraction was allowed to continue in a refrigerator (5–7° C.) for one week; the *p*H was occasionally adjusted to 8·5 with 5 *N* ammonium hydroxide. The extract separated from the cellular debris showed a broad absorption band from 545 mμ to 565 mμ on addition of dithionite, which was composed of the reduced α-bands of cytochrome *c* and b_2. The extract was fractionated by solid ammonium sulphate to get the fraction at 45–75 per cent saturation. The contaminated cytochrome *c* was removed by washing the fractionated precipitate with 75 per cent saturated ammonium sulphate solution. The washed precipitate was dissolved in a small amount of distilled water and dialysed against distilled water in the refrigerator. The inner solution was then passed through a column of cation-exchange resin (100–150 mesh), 'Duolite CS-101', buffered at *p*H 5·0. If buffered at *p*H higher than 6·0, and also in the case of a very impure sample, the resin failed to adsorb cytochrome b_2. Buffering at too low *p*H caused denaturation.

The solution was almost the same brownish-red colour before and after passage through the column. The cytochrome b_2 was adsorbed as a coral-pink colour at the top of the column. The charged column was washed with distilled water until the eluate became completely clear. The elution proceeded using 0·4 *M* ammonium phosphate buffer (*p*H 7·4). Immediately after the pink substance (cytochrome b_2), a brownish-yellow substance flowed out which was removed with loss of a small amount of cytochrome b_3.

The pink-coloured fractions were mixed with 30 gm. ammonium sulphate per 100 ml. After centrifuging, the supernatant was treated with 20 gm. ammonium sulphate. The precipitate was collected by centrifugation, dissolved in a small amount of distilled water and dialysed against distilled water in the refrigerator. The inner solution after centrifuging to remove insoluble matter was passed through the 'CS-101' column by the same method as described above. The fairly pure cytochrome b_2 was adsorbed as a pink colour on the top of the column. After washing with distilled water, the column was treated with 0·4 *M* ammonium phosphate buffer (*p*H 5·0) for each 1-ml. fraction (Fig. 1). To the best fractions (E(411 mμ)/E(278 mμ) > 1·30) collected was added finely powdered ammonium sulphate to 60 per cent saturation. The mixture was centrifuged and the precipitate dissolved in the minimum amount of distilled water. After removing the insoluble matter

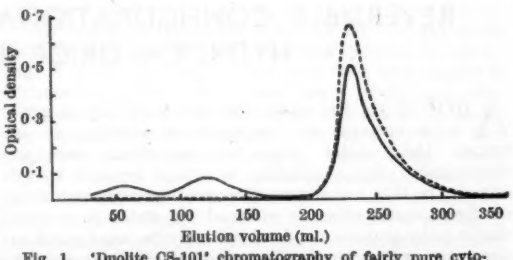

Fig. 1. 'Duolite CS-101' chromatography of fairly pure cytochrome b_2. The solid line expresses the optical density at 278 mμ and the broken line that at 411 mμ in oxidized form

by centrifugation, finely powdered ammonium sulphate was carefully added little by little to the pinkish-red solution until it became slightly turbid. The turbid solution gradually increased in turbidity and crystallized after standing in the refrigerator for a few days. Recrystallization was carried out without loss of cytochrome b_2 by the same method. The above procedure was quite reproducible and provided 1 mgm. of crystals per kgm. of the pressed baker's yeast.

The isolated crystals (Fig. 2) were shown to be a homogeneous protein by electrophoretic and chromatographic criteria, and had no yeast lactic dehydrogenase activity. The absorption spectrum of the crystalline cytochrome b_2 was measured by a Beckman spectrophotometer as shown in Fig. 3. The positions of the absorption bands are as follows: in oxidized form, 563 mμ, 411 mμ, 359 mμ and 278 mμ; in reduced form, 557 mμ, 528 mμ and 422 mμ. The band at 563 mμ is measurable only in concentrated solution. The yeast lactic dehydrogenase purified by the method of S. J. Bach, M. Dixon and L. G. Zerfas[3] slightly modified by us (Yamanaka, T., Higashi, T., Matsubara, H., Horio, T., and Okunuki, K., unpublished work) from the same source (involving grinding the cells with sand in the first stage and precipitation of the enzyme by dialysis of the fairly purified and concentrated enzyme against de-ionized water in the refrigerator with loss of a large amount of the total activity) was very similar to that of C. A. Appleby and R. K. Morton[4] in respect of specific activity and adsorption bands, except for that at 258 mμ, which is approximately twice as high. Though cytochrome b_2 could be isolated from the enzyme solution, the yield was markedly less than by the method described above.

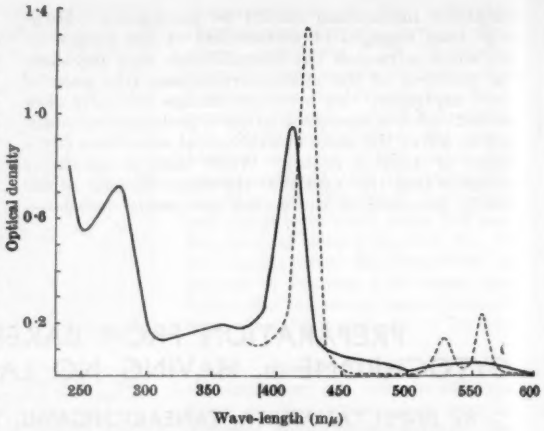

Fig. 3. Absorption spectrum of crystalline cytochrome b_2. It was measured in 0·1 *M* phosphate buffer (*p*H 8·0) using twice-recrystallized cytochrome b_2. Reduction was carried out by the addition of a few pieces of dithionite. The solid line refers to the oxidized form and the broken line the reduced form

Fig. 2. Crystalline cytochrome b_2. Crystallization was always carried out from the solution of $E(278\ m\mu) > 20$. Each of the crystals is composed of a bundle of extremely slender needle-like ones. × 1,500

The cytochrome b_2 did not restore yeast lactic dehydrogenase activity on the addition of flavine mononucleotide, flavine adenine dinucleotide, and heat-denaturated enzyme solution, but was reduced by lactate in the presence of a small amount of the yeast lactic dehydrogenase in anaerobic condition, stimulated by the addition of flavine mononucleotide. The enzymic reduction of cytochrome b_2 by reduced tri- and di-phosphopyridine nucleotide will be reported elsewhere.

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REVERSIBLE CONFIGURATIONAL CHANGES IN POLY-L-LYSINE HYDROCHLORIDE INDUCED BY WATER

ALTHOUGH the molecular configuration of proteins cannot yet be specified exactly, it is known that water plays an important part in determining the properties of many protein molecules[1]. In this communication we describe reversible configurational changes induced by water in a synthetic poly-α-amino-acid which may be analogous to those occurring in certain proteins. High-molecular weight poly-L-lysine hydrochloride ($\eta_{sp}/c = 1·05$, $c = 0·2$ per cent in 2 *M* aqueous sodium chloride; Idelson, M., and Blout, E. R., to be published), the polyamino-acid used in this investigation, is readily soluble in water and coherent films can be deposited from aqueous solutions. When the water content of oriented films of poly-L-lysine hydrochloride is altered, the infra-red spectra of such films show definite changes in both the position and dichroism of the absorption bands characteristic of the peptide

group of polypeptides; this indicates that configurational changes have occurred within the poly-L-lysine hydrochloride molecules.

Unoriented films of poly-L-lysine hydrochloride prepared at 22–26° C. and at relative humidity in the range 50–60 per cent show an amide I (C=O stretching) frequency at 1,655 cm.$^{-1}$ when the spectrum is determined soon after preparation; but this absorption band shifts in frequency as the film ages. Elliott[2] has shown that the carbonyl amide I band of poly-L-lysine hydroiodide shifts from 1,654 cm.$^{-1}$, the characteristic frequency of α-forms of polypeptides, to 1,646 cm.$^{-1}$ upon exposure of a film to 80 per cent relative humidity. We have observed a similar change in films of the hydrochloride and, in addition, when such films are dried over phosphorous pentoxide, the carbonyl amide I frequency shifts to 1,625 cm.$^{-1}$, the characteristic frequency of β-forms of polypeptides. (In this connexion it should be noted that low-molecular weight polypeptides (degree of polymerization less than 8) also show amide I frequencies between 1,625 and 1,630 cm.$^{-1}$ and have been denoted as β-polypeptides, see ref. 3). However, since the low-molecular weight β-polypeptides cannot be converted to α-helical forms, it would be desirable to differentiate them from high-molecular weight polypeptides which are capable of such configurational changes. We therefore suggest designating the β-forms of low-molecular weight polypeptides as β_l, and the β-forms of high-molecular weight polypeptides as β_h.)

The observed changes of the amide I band between 1,645 cm.$^{-1}$ and 1,625 cm.$^{-1}$ are completely reversible with change of relative humidity, but the 1,655 cm.$^{-1}$ band is only observed upon solution and redeposition of the poly-L-lysine hydrochloride.

Oriented films of poly-L-lysine hydrochloride show similar changes in frequency and marked changes in dichroism with variations in humidity. The infra-red spectra of one such film, after equilibration at different water contents, are shown in Figs. 1, 2 and 3. The

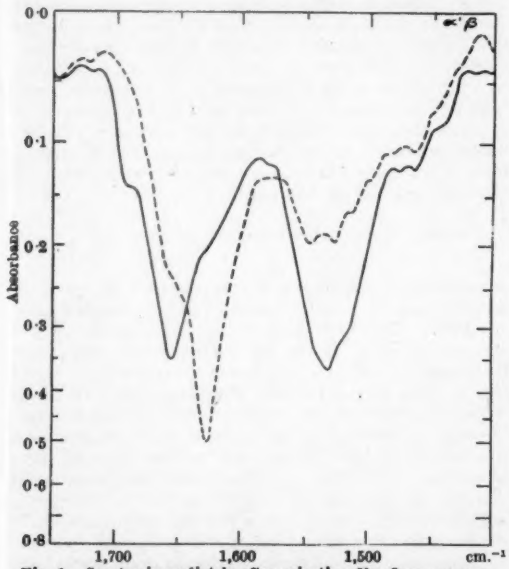


Fig. 1. Spectra immediately after orienting film from aqueous solution. Note C=O amide band of α' at 1,655 cm.$^{-1}$ (∥ dichroism) and C=O amide band of β_h at 1,625 cm.$^{-1}$ (⊥ dichroism)

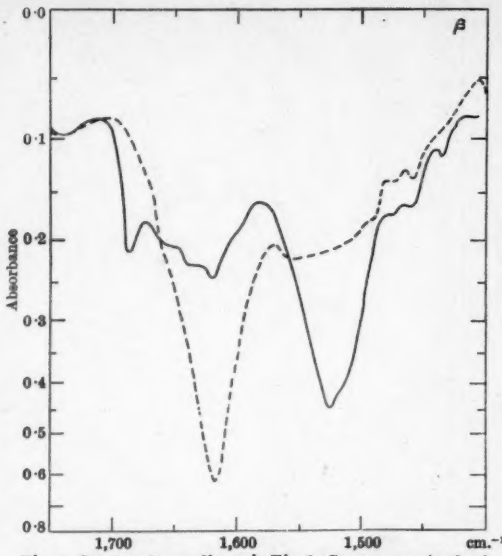


Fig. 2. Spectra of same film as in Fig. 1 after exposure to about 65 per cent relative humidity for 5 hr. Note C=O amide band of β_h at 1,625 cm.$^{-1}$ (⊥ dichroism)

oriented film was produced by unidirectional rubbing of a concentrated solution of the hydrochloride until solid. The original infra-red spectrum (Fig. 1) shows two amide I absorption maxima: one with parallel dichroism at 1,655 cm.$^{-1}$ (α'), and a stronger maximum with perpendicular dichroism at 1,625 cm.$^{-1}$ (β_h). (The dichroism is parallel if the absorption is greatest when the electric vibration direction of the incident linearly polarized radiation is parallel to the orientation direction. The dichroism was measured using an improved method[4] that avoids certain common errors.) The intensity of the α'-band (1,655 cm.$^{-1}$) varies in different films prepared from the same sample of poly-L-lysine hydrochloride. The specimen giving Fig. 1 has as strong an α'-band as any we have observed. The amide II frequency is broad and shows parallel dichroism, and there is observed an additional weaker band with parallel dichroism at 1,690 cm.$^{-1}$.

After exposing the same oriented film to a relative humidity of about 65 per cent for 5 hr., however, the spectrum shown in Fig. 2 was obtained. The principal change observed was the disappearance of the component of the amide I band at 1,655 cm.$^{-1}$ (the α'-band) which showed parallel dichroism, leaving only the strongly perpendicularly dichroic band at 1,625 cm.$^{-1}$. Exposure of the film to 90 per cent relative humidity for 7 hr. did not alter its spectra further.

The oriented film then was left at 100 per cent relative humidity for 3 hr. and the spectra shown in Fig. 3 were obtained. Not only was the amide I absorption shifted to 1,645 cm.$^{-1}$, but also the dichroism of both this band and the amide II band were reversed—the dichroism now being parallel and perpendicular for amide I and II, respectively. Also, the 1,690 cm.$^{-1}$ band had now disappeared. Lowering the water content of this film by exposure to relative humidity less than 60 per cent shifted the amide I band back to 1,625 cm.$^{-1}$, and perpendicular dichroism was observed again in this band, with parallel dichroism being shown again in the amide II band.

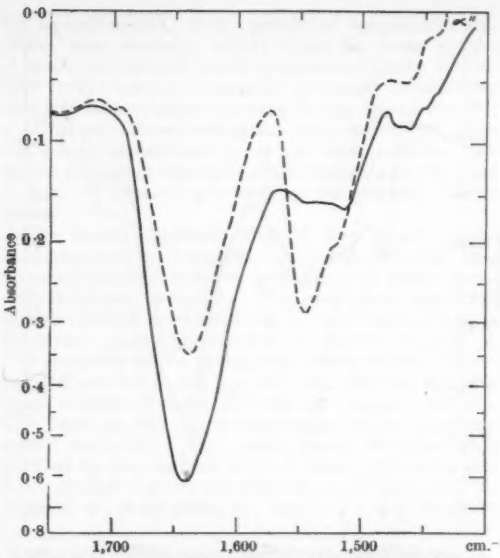


Fig. 3. Spectra of same film as in Fig. 2 after exposure to 100 per cent relative humidity for 3 hr. Note C=O amide band of α'' at 1,645 cm.$^{-1}$ (‖ dichroism)

All figures: Infra-red spectra of poly-L-lysine hydrochloride unidirectionally oriented film (on silver chloride plate). ——, Spectrum obtained when electric vibration direction of incident polarized radiation parallel to orientation direction; – – –, spectrum obtained when electric vibration direction of incident polarized radiation perpendicular to orientation direction

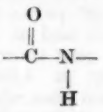
Some loss in the amount of dichroism, probably due to disorientation of the film at high relative humidity, was observed.

Such changes in dichroism and position of the amide bands have been observed for several humidity cycles with this material. Another sample of poly-L-lysine hydrochloride having lower molecular weight ($\eta_{sp}/c = 0{\cdot}55$, C = 0·2 per cent in 2 *M* aqueous sodium chloride) showed similar changes in dichroism and frequency of the infra-red absorption bands at lower relative humidity values.

With polypeptides, changes in the frequency and the dichroism of the amide I and amide II bands have been associated with changes in the configuration of such molecules. In particular, it has been shown[5] that an amide I frequency of about 1,655 cm.$^{-1}$ with parallel dichroism is probably associated with folded intramolecularly bonded or α-forms, whereas an amide I frequency of about 1,625 cm.$^{-1}$ with perpendicular dichroism probably can be related to extended intermolecularly bonded or β-forms. From our infra-red dichroism results it appears that poly-L-lysine hydrochloride exists in two different structural modifications—α and β. On the basis of the infra-red frequency results, we further differentiate the α-form into α' and α'' until it is fully determined that the frequency differences noted are due to added water absorption alone[3]. The spectral properties are as follows:

	Amide I		Amide II	
Form	Frequency (cm.$^{-1}$)	Dichroism	Frequency (cm.$^{-1}$)	Dichroism
α'	1,655	‖	~1,540 (broad)	
↓				
β_A	1,625	⊥	1,530	‖
$-H_2O \uparrow \downarrow + H_2O$				
α''	1,645	‖	1,550	⊥

In the present instance, the infra-red results show that the spatial configuration of the



group relative to the orientation direction is greatly altered by the degree of hydration of this polymer. Although from the infra-red dichroism one cannot indicate the precise spatial orientation of the C=O group, it is apparent that there is a change of approximately 90° in its orientation in the presence of water compared to its position at lower humidities. The fact that corresponding changes occur in the amide II band (associated with coupled N—H deformation and C=N stretching frequencies[4]) confirms this conclusion. Polarization spectra have been obtained also at 30° and 60° to the orientation direction, but in all cases the maximum dichroism was observed at 0° and 90°.

It is reasonable to assume that as water is removed from the neighbourhood of a charged poly-ion, such as poly-L-lysine hydrochloride, the charge shielding is lowered and the resulting dipolar repulsions would tend to force the chains to extended β-configurations. The spectra shown in Fig. 2, which were obtained on an essentially dry film, correspond both in the positions and dichroism of the absorption bands to β_A or extended forms in which the carbonyl amide groups lie perpendicular to the orientation of the backbone of the molecules. An analogous (extended) configuration has been noted in oriented films of sodium poly-L-glutamate[7], where the ionization of the γ-carboxyl groups would be expected to have an effect similar to the ionized ε-amino-groups of poly-L-lysine hydrochloride.

On the other hand, the spectra obtained when the film is hydrated (Fig. 3) correspond in dichroism to those observed with α-forms of polypeptides. It should be noted, however, that the frequency of the C=O band of amide I is about 10 cm.$^{-1}$ lower than in polypeptides such as poly-γ-benzyl-L-glutamate[8], which have been shown to exist in an α-helical form[9]. Despite this abnormally low amide I frequency, it appears that poly-L-lysine hydrochloride when hydrated exists as an α-helix, but the amide I frequency may be lowered by the sheath of hydrated $—NH_3^+Cl^-$ groups surrounding the core.

The experiments reported here involving $\alpha'' \underset{+H_2O}{\overset{-H_2O}{\rightleftharpoons}} \beta_A$ transformations indicate the importance of water in determining the configuration of poly-L-lysine hydrochloride. Measurements of the increase in water content of films of the hydrochloride in the range from zero to 60 per cent relative humidity (where the β_A-form exists) indicate that less than two molecules of water are absorbed per amino-acid residue. On the other hand, films exposed to 80–98 per cent relative humidity (where the α-form exists) have absorbed four to six water molecules per amino-acid residue. If the amount of water is further increased, solution occurs and the α-helical configuration is destroyed. For example, in a 2 per cent aqueous solution of poly-L-lysine hydrochloride there are approximately 500 water molecules per amino-acid residue, and optical rotation measurements show that

a non-helical configuration exists. Further evidence that β-polypeptide ⇌ α-helix configuration changes occur upon varying the water content of poly-L-lysine hydrochloride has been obtained from X-ray diffraction investigations (Cohen, C., Emerson, E., and Blout, E. R., unpublished work).

In the past, changes in the spectra of poly-L-glutamic acid upon ionization[7] and poly-D,L-alanine upon heating[10] which correspond to conversions of α- to β-forms have been observed. However, the spectral changes seen with poly-L-lysine hydrochloride are unique in that they are brought about solely by variations in water content of the polypeptide, and are completely reversible by this means alone. From the observations reported in this communication, it is evident that the number of water molecules surrounding the polypeptide chain (or conversely, the concentration of polypeptide) determines its configuration, as indeed may be the case with certain proteins.

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E. R. Blout*
H. Lenormant†
The Children's Cancer Research Foundation,
Boston 15,
Mass.
Dec. 5.

* Chemical Research Laboratory, Polaroid Corporation, Cambridge 39, Mass.
† Faculté des Sciences, Université de Paris.

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We are indebted to Dr. E. R. Blout and Prof. H. Lenormant for having given us an opportunity to comment on their very interesting results on chain configuration changes in poly-L-lysine hydrochloride.

In a series of observations which commenced several years ago, we have observed similar changes of configuration in films of all four hydrohalides of poly-L-lysine, but certain anomalies have caused us to delay publication. However, we entirely agree that, in general, exposure of α films of these materials to water (or, as we have found, to heavy water) at suitable humidity produces the β-form, as shown by the 1,625 cm.$^{-1}$ CO band which appears. We find, however, that the rate of drying exerts a great influence on the behaviour of the polymer films. Rapid drying at 0° C. (in a dry air stream) produces the 1,655 cm.$^{-1}$ peak of the α-form with all four hydrohalides, and exposure of these dried films to water vapour at 32 per cent relative humidity at 27° C. produces a β-peak at 1,625 cm.$^{-1}$. Films dried rapidly at 60° C. behave similarly, except that in the case of the hydrochloride, the β-peak is present before exposure to water vapour.

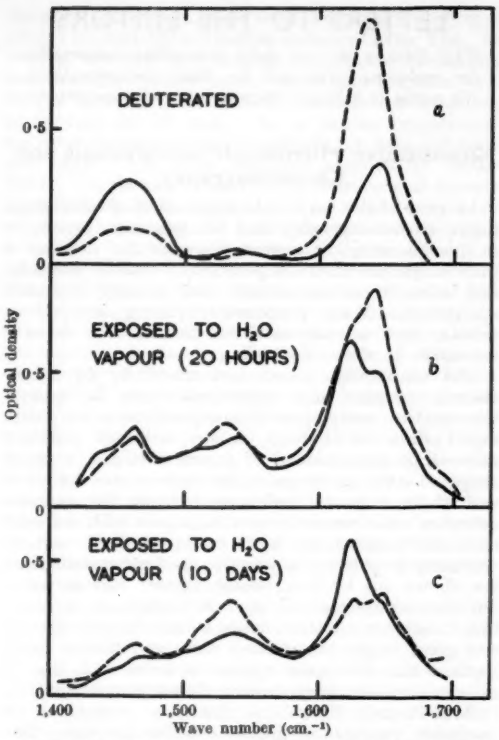

Fig. 1. Infra-red spectra of poly-L-lysine hydroiodide in polarized radiation. ——, *E*-vector perpendicular to fibre axis; – – –, *E*-vector parallel to fibre axis

These experiments are complementary to those of Blout and Lenormant, in that the β-form is obtained by increasing instead of decreasing the relative humidity. We have obtained similar results with heavy water vapour, though some anomalies, which must be discussed further when time and space permit, have been observed. One such is illustrated in Fig. 1, which shows an oriented specimen of poly-L-lysine hydroiodide, apparently in equilibrium with heavy water vapour at 80 per cent relative humidity, in the α-form. Exposure to ordinary water vapour at the same humidity has in this specimen produced the reversed dichroism of the β-form. These spectra also show that the amide band at 1,460 cm.$^{-1}$, produced on deuteration of the NH group[1], has dichroism opposite to that of the CO band. It will be seen that complete rehydrogenation has not been achieved; this and other effects which we have observed are doubtless connected with the degree of crystallinity in the polymer, which changes during the course of the experiments. It should perhaps be mentioned that the band at 1,690 cm.$^{-1}$ to which Blout and Lenormant refer has been ascribed to the β-polypeptide chain[2].

A. Elliott
B. R. Malcolm
W. E. Hanby

Research Laboratory,
Courtaulds, Ltd.,
Maidenhead, Berks.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Quantitative Microscopic Ionophoresis and Chromatography

In view of the very wide application of microgram paper chromatography and ionophoresis, especially in biochemistry, it seems desirable to develop a microscopic modification potentially equally versatile, and using relatively simple and readily available apparatus. Many problems requiring analysis at cellular and subcellular levels would then become accessible to these methods.

The sensitivity, speed and specificity of microchromatography and ionophoresis can be greatly increased by carrying out the separation in very thin liquid films (0·01–10μ) on an ordinary polished microscope slide instead of porous columns or paper strips. 1–100 $\mu\mu$l. drops of the mixture are delivered and their volumes determined from the circular reflexion interference fringes they give with mercury monochromatic green light, using a Beck vertical illuminator. After analysis the resolved constituents are shown up by the 'breath figure' test as areas differing in hydrophobicity. A continuous aqueous film condenses on the surface ('black breath figure') and gives bright interference tints in reflected light. Against this the zones appear as areas with less or no condensation, or as a matt of microscopic droplets ('white breath figure')[1]. Since a monolayer of inorganic cations or grease can be detected, this property offers an extremely sensitive method for observing microscopic zones.

Simple inorganic salt mixtures have been used for the initial development of the method. Less than 1 $\mu\mu$gm. of each cation can be quantitatively resolved, using $\frac{1}{2}$–1 in. microscope objective and × 30–375 magnification, thereby attaining a 100-millionfold or more increase in sensitivity over paper strip methods. An actual run takes only 20–180 sec. and the whole separation may involve 0·25–5·0 mm. of the slide. Higher powers should give correspondingly greater sensitivity.

The analysis is carried out in a glass humid chamber on a platform attached to a microscope vernier stage. A perfectly clean microscope slide is used, sometimes with a supporting film such as a trace of 'Teepol'. Even a single dust particle may contaminate a millimetre or more of the surface. Inverting the slide gives excellent dust protection and is convenient for micro-manipulation and humidity control. Platinum wire electrodes moistened with dilute hydrochloric acid are used for making contact with the slide. A simple micropipette attached to a Goldacre micromanipulator[2] delivers mixtures containing 0·15–1·5 μM/ml. of one or more of each of the cations Pb^{2+}, Fe^{2+}, Zn^{2+}, Cu^{2+}, Ba^{2+} and La^{3+}. The 1–100 $\mu\mu$l. drops spread out to a fairly stable, circular, very flattened lens of volume:

$$V = \tfrac{1}{2}\pi\lambda(r_1^2 + 2r_2^2 + \ldots 2r_{n-1} + \tfrac{3}{2}r_n^2 + \tfrac{1}{2}r_{n+1/2})\text{ml.}$$

where r_1, r_2, . . . r_n, is the radius of the innermost, second, . . . and outermost fringe, respectively, $r_{n+1/2}$ the estimated radius when drop thickness reaches zero peripherally, and λ the wave-length of the light. Only 0·5–2·0 per cent volume change/min. occurs with 30–80 $\mu\mu$l. drops, and this can be corrected for by extrapolation to zero time. This method of measuring microdrop volume is also employed in a membrane interferometric microrespirometer[3]. The solution flooding the chamber floor controls the concentration of the drop and creates a reproducible aqueous film on the slide through osmotic equilibrium. Hydrochloric, trichloracetic or other acid is deposited from the vapour through a side tube or outside the chamber and, after equilibrium, a direct current at 30–70 V./cm. applied for 20–180 sec., ammonia vapour admitted, and the film dried. The areas of the resolved zones are taken as a measure of the quantity in each[4].

Dilute acid films give endosmosis and cation separations towards the cathode, endosmosis rapidly diminishing with increasing acidity[5]. If 'Teepol' is present, endosmosis is reversed to the anode and is more rapid[5]. Cations then separate towards both electrodes with dilute acids and only to the cathode under more acid conditions. These results indicate that the separations probably involve both ionophoresis towards the cathode, and ion-exchange chromatography towards the anode with endosmosis providing the solvent flow, possibly complicated by complex formation with the 'Teepol' or trichloracetic acid. A neutral or slightly acid film increases adsorption, endosmosis and complex formation, and separations tend towards the anode; whereas these factors are lessened by more acid conditions, so that ionophoresis towards the cathode then predominates. Such combined mechanisms can also operate in inorganic paper ionophoresis[6].

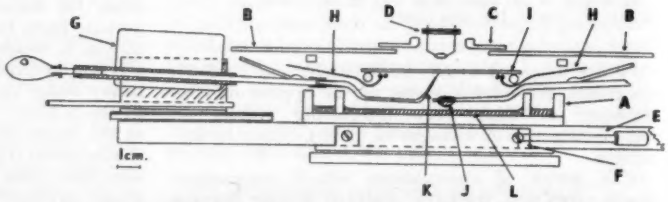

Fig. 1. Ionophoresis chamber (side view). *A*, Glass humid chamber; *B*, sliding lids; *C*, central lid; *D*, microscope objective; *E*, 'Perspex' platform; *F*, microscope vernier stage; *G*, Goldacre micromanipulator; *H*, platinum wire electrodes; *I*, microscope slide; *J*, drop of salt mixture on 'Pyrex' rod attached to second micromanipulator (where necessary); *K*, micropipette ending in drawn-out capillary for drop delivery; *L*, bulk solution flooding floor of chamber

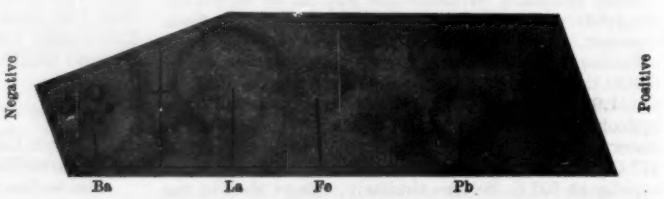

Fig. 2. Resolution of inorganic cations. × 26. 15 m$\mu\mu$ *M* (approximately 1·5 $\mu\mu$gm.) each cation. Aqueous 'Teepol'/trichloracetic acid film. 30 V./cm., 30 sec. Endosmosis approximately 25 μ/sec. to the anode

Fuller details of these experiments, which were begun in 1949, will be published elsewhere. The advice of Dr. J. Stern, of the Fountain Hospital, London, S.W.17, and of Dr. G. W. Scott Blair, National Institute for Research in Dairying, Reading, is gratefully acknowledged, and Mr. Michael Kaye and Edward Sterndale are thanked for their help with the photography.

B. M. TURNER

Turner Lighter Spares and Components, Ltd.,
Burroughs House,
Hendon Central,
London, N.W.4.
March 2.

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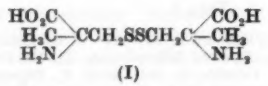
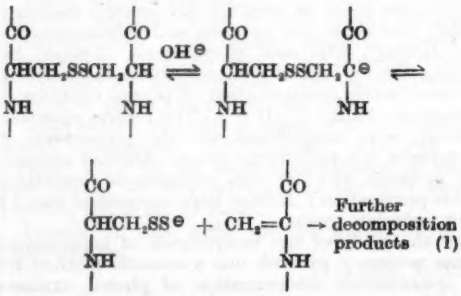
Mechanism of Alkaline Degradation of Cystine Residues in Proteins

IN order to provide a test of the different mechanisms proposed for the alkaline degradation of disulphide groups in proteins, the amino-acid α,α′-dimethylcystine (I) has been synthesized and examined :



(I)

If direct hydrolysis of the sulphur–sulphur bond[1] or ionization of a proton adjacent to one of the sulphur atoms[2] is the initial step leading to breakdown, then the new compound should be as labile to alkali as cystine. On the other hand, if cystine degradation is initiated by ionization of the amino-acid α-hydrogen atom, followed by β-elimination of an unstable disulphide anion[3] (equation 1), then the new amino-acid would be expected to be very much more stable to alkali than cystine, since the hydrogen atom essential for ionization and β-elimination is replaced by methyl.



Such an increased stability is in fact observed. The reactions were followed by colorimetric and polarographic estimation of thiol and disulphide, and in boiling 0·25 *N* sodium hydroxide α,α′-dimethylcystine is almost unchanged after 3 hr. and only 50 per cent is decomposed after 18 hr. Under the same conditions, 89 per cent of cystine is destroyed after 1 hr. and 100 per cent is destroyed after 2 hr. In boiling 2·4 per cent calcium hydroxide containing lead acetate, cystine rapidly gives lead sulphide, and 80 per cent of the theoretical amount of ammonia is evolved in 15 min. In a similar experiment α,α′-dimethylcystine gave virtually no lead sulphide and only 3 per cent ammonia after 6 hr. under reflux. On the other hand, in its reaction with known disulphide-splitting agents such as sulphite, cyanide or silver ions, and its behaviour at the dropping mercury electrode, the new amino-acid is almost indistinguishable from cystine. Any explanation of the stability to alkali based on steric effects of the methyl groups would therefore seem unlikely.

It has also been found that cystine dimethyl ester decomposes on standing for 48 hr. in cold methanol containing triethylamine to give a deep red solution from which elementary sulphur crystallizes, in total yield corresponding to decomposition of the disulphide anion (equation 1) to thiol anion plus sulphur. The alternative mechanisms[1,2] do not easily account for the ready formation of free sulphur. It is also of interest that lanthionine could be detected in the decomposition products. In contrast, the dimethyl ester of α,α′-dimethylcystine shows only slight decomposition even after prolonged refluxing in methanolic triethylamine.

The slow degradation in hot aqueous alkali of α,α′-dimethylcystine and of other disulphides for which β-elimination is not possible may well proceed by reactions of the kind envisaged by Rosenthal and Oster[3] or by Schöberl and Speakman[1], or in still other ways. It is suggested, however, that the β-elimination mechanism (equation 1) is of first importance in the action of alkali on cystine and on peptides and proteins containing cystine. The possibility also arises that proteins such as wool could be stabilized against alkali if a reagent could be found able to substitute the cystine α-hydrogen atoms.

I wish to thank Mr. I. W. Stapleton for technical assistance. This work will be reported in greater detail elsewhere.

J. M. SWAN

Biochemistry Unit,
Wool Textile Research Laboratories,
Commonwealth Scientific and
Industrial Research Organization,
Melbourne.
Feb. 1.

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Resolution of Hyaluronidase and Ribonuclease Activities

TESTICULAR hyaluronidase has frequently been used for the analysis of hyaluronic acid and chondroitin sulphate despite the known gross inhomogeneity of the enzyme preparation[1,2]. Known contaminants include acid phosphatase, esterase, β-galactosidase, β-glucuronidase, glucosidases and N-acetylglucosaminidases[2]. To our knowledge, there has been no previous report of contamination of hyaluronidase with ribonuclease.

Table 1

Material	Ribonuclease per mgm. nitrogen	Hyaluronidase per mgm. nitrogen	Ratio of hyaluronidase to ribonuclease	Yield of hyaluronidase (per cent)
Starting	230	8,500	39	
0–0·60 sat.	40	22,000	550	91
0·60–0·80 sat.	185	645	3	4

Hyaluronidase activity was determined turbidimetrically using the starting enzyme preparation as reference material[4]. Ribonuclease activity was assayed by the turbidimetric method described below. Protein was determined by total nitrogen analyses on isolated material. All fractionations were carried out at 0–3°.

1 gm. of partially purified testicular hyaluronidase which assayed 1,250 TRU per mgm. was dissolved in 25 ml. of 0·2 *M* phosphate buffer *p*H 5·4. The solution was transferred to a column containing 100 ml. of '*XE*-64' resin equilibrated against the same buffer. The column was washed with 200 ml. of the buffer and eluted by a gradient technique with 0·2 *M* phosphate buffer, *p*H 6·3, in a 1-litre mixing vessel and 0·2 *M* phosphate buffer, *p*H 7·4, in the reservoir. Twenty ml. fractions were collected and screened for hyaluronidase activity as described. A broad peak of activity appeared in tubes 55–93. These were combined, dialysed against distilled water and lyophilized. The isolated material still exhibited appreciable ribonuclease activity.

The isolated material was redissolved in 50 ml. of distilled water and the resulting solution was made 0·60 saturated with ammonium sulphate. After standing for 1 hr. at 0°, the precipitate was isolated by centrifugation at 16,000*g* for 30 min. The residue was dissolved in 20 ml. of 0·1 *M* phosphate–citrate buffer, *p*H 6·0, dialysed against the buffer for 24 hr., finally against distilled water for 4 hr. and then lyophilized. The yield was 442 mgm. of solid material. The supernatant remaining after removal of this fraction was treated with sufficient additional ammonium sulphate to raise the concentration to 0·80 saturation and the resulting precipitate worked up as above. A summary of the purification is given in Table 1.

The methods previously described for ribonuclease assay generally involve either radioactivity, phosphorus or spectrophotometric determinations on trichloracetic acid or uranium salt filtrates of incubation mixtures[5]. The turbidimetric estimation of residual ribonucleic acid by precipitation with acid alcohol has also been described[6]. None of these methods is conveniently applicable to a large number of determinations. The following procedure is rapid, sensitive, convenient and does not require unusual substrates or equipment.

Yeast ribonucleic acid is dissolved in 0·2 *M* phosphate buffer, *p*H 5·6, to give a final concentration of 1·0 mgm. per ml. 1 ml. of this solution is incubated for 20 min. at 37° with 1·0 ml. of enzyme solution. Generally, at least five dilutions of enzyme are employed. At the end of the incubation period, 10 ml. of bovine serum albumin ('Armour fraction V') solution (0·5 mgm. per ml. in 0·2 *M* acetate buffer, *p*H 4·0) is added and the solution is thoroughly mixed. The resulting turbidity is read after exactly 5 min. at 420 mμ in an appropriate colorimeter. As little as 0·03γ of ribonuclease can be detected by this method with good precision.

The presence of significant ribonuclease activity in a partially purified commercial testicular hyaluronidase is of considerable importance to workers engaged in histochemical or biochemical studies where the enzymatic treatment is believed to have a fair degree of specificity. The purification procedure described is relatively simple to carry out and reduces the ribonuclease activity to insignificant levels at the hyaluronidase concentrations normally employed.

We thank Dr. Harvey Alburn of Wyeth, Inc., for a generous gift of testicular hyaluronidase used in this study. The ion exchange resin '*XE*-64' is a finely ground carboxylic acid-type resin similar to '*IRC*-50' and can be obtained from Rohm and Haas, Inc., New York.

The Rackham Arthritis Research Unit is supported by a grant from the Horace H. Rackham School of Graduate Studies of the University of Michigan. This investigation was supported in part by a grant from the National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, and a grant from the Michigan Chapter, Arthritis and Rheumatism Foundation.

Eugene A. Davidson
Donald R. Watson
Saul Roseman

Rackham Arthritis Research Unit and
Department of Biological Chemistry,
University of Michigan,
Ann Arbor,
Michigan.
Feb. 4.

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Determination of Phenol Oxidase using a Manometric Method by *Streptomyces antibioticus*

The study of phenol oxidases in Actinomycetes has been complicated by insurmountable methodological difficulties. While it has been possible to isolate effective preparations of phenol oxidase from moulds that could be used for manometric measurements[1], this could not be done with Actinomycetes. Only Küster[2], who used preparations obtained by grinding the mycelia of Actinomycetes, succeeded in the manometric determination of phenol oxidases in a phosphate buffer of *p*H 6·8. The results obtained, however, were insignificant and the preparation of the mycelia not sufficiently exact. Another undesirable property was the high endogenous respiration of this preparation; Küster later suppressed this by using malachite green.

For the study of the biosynthesis of actinomycin it was necessary to work out a suitable method for the quantitative determination of phenol oxidases by Actinomycetes. I believed that the biosynthesis of actinomycin, as a quinone antibiotic, is catalysed probably by phenol oxidases. In a study of phenol oxidases in *Streptomyces antibioticus* No. 105/5 producing actinomycin, a manometric method was used. Sodium cholate, a surface-active agent, was used, thus permitting the specific substrate to enter intact

cells. In addition, this also considerably inhibited the high endogenous respiration.

Sodium cholate, 0·1 ml. of a 4 per cent aqueous solution, was added to make up the total volume of fluids in the Warburg vessel to 3 ml. This resulted in very good oxidation of specific substrates (catechol, hydroquinone, *p*-phenylenediamine) by intact mycelia of Actinomycetes and also inhibited endogenous respiration (Table 1).

Table 1. Influence of Various Concentrations of Sodium Cholate on Oxidation of Hydroquinone

Sodium cholate in the Warburg vessel (per cent)	0·008	0·016	0·033	0·066	0·133
Oxygen uptake per flask (μl.)	45	93	142·5	168·5	168

For manometric determinations, 2 ml. of a suspension of Actinomycetes mycelia (22 mgm. dry weight) in a phthalate buffer *p*H 4·5 are added to a Warburg vessel. The mycelium prepared by cultivation in a rotating shaker was twice washed with distilled water. 0·1 ml. of a 4 per cent solution of sodium cholate was added to the suspension of mycelia. The centre well contained 0·2 ml. of a 10 per cent solution of potassium hydroxide, while the side-arm contained 0·9 ml. of a solution of the specific substrate in distilled water.

Catechol, hydroquinone, *p*-phenylenediamine, *p*-cresol and tyrosine served as substrates in a concentration of 5 mgm./ml. (Tyrosine as a suspension, *p*-phenylenediamine solution was adjusted to *p*H 5·5 using hydrochloric acid.) Oxygen consumption was measured at 30° C.

The effect of sodium cholate on endogenous respiration and oxidation of catechol in mycelia of *Streptomyces antibioticus* of different ages is shown in Table 2.

Table 2. Influence of Sodium Cholate on Endogenous Respiration and Oxidation of Catechol

Ages of mycelium	Without sodium cholate		With sodium cholate	
	Endogenous respiration	Catechol	Endogenous respiration	Catechol
2 days	142	128	26·5	31
3 days	177	147	16·5	38
4 days	76·5	61	14·5	98·5
5 days	66	68	18	149
6 days	47	77	17	149
7 days	18	98	0	221·5

Using sodium cholate, it is possible to measure catechol oxidation even in very young cultures of Actinomycetes. The cholate probably causes the substrate to enter the cells of the mycelia, where it is oxidized by endoenzymes. The oxidized product returns to the medium from the cells.

Good results were also obtained with other surface-active substances; for example, 'Syntergit' and 'Likorol *VEL*' at the same concentration as cholate and 'Tween 80' (0·1 ml. of a 15 per cent aqueous solution per 3 ml. of fluid).

Details of this work will be published in *Čs. Mikrobiologie*.

Vladimír Ševčík

Department of Microbiology,
Institute of Biology,
Czechoslovak Academy of Science,
Prague 6.
Dec. 4.

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Effect of a Prolonged Fast on the Apparent Galactose Uptake of the Isolated Rat Diaphragm *in vitro*

During an investigation of the effects of fasting on the transfer of sugars across the cell membrane, it was noted that the uptake of galactose by the rat's isolated diaphragm *in vitro* was significantly increased after a prolonged fast, as determined from the incubation medium by a copper reduction method.

Normal male albino Wistar rats of 150–200 gm. were fasted for 96 hr. Tap water was fed *ad libitum*. The control rats received a standard laboratory diet[1] and tap water freely. The diaphragms were washed for 5 min. in ice-cold Krebs–Ringer phosphate buffer[2] to which galactose had been added (2 mgm./ml.); oxygen was continuously bubbled through the buffer. The muscles were incubated in a Warburg manometric apparatus each in a 15-ml. flask into which 2 ml. buffer containing 2 mgm./ml. galactose had been added. The flasks were gassed with oxygen and shaken for 1 hr. at 37° C. (80 cycles/min.). After incubation the sugar residue in the medium was determined colorimetrically by Somogyi's method[3] using Nelson's colour reagent[4] after having first adsorbed possible intracellularly produced glucose on washed baker's yeast[5].

The results are summarized in Table 1.

Table 1

Galactose uptake. Mean ± S.E. of mean (mgm. galactose/gm. of wet diaphragm)

Non-fasted		Fasted		Difference	t	P
0·64 ± 0·09	(8)	1·06 ± 0·12	(9)	0·42 ± 0·16	2·8	<0·01

Figures in parentheses are numbers of animals.

In similar experiments with glucose, no difference between the fasted and non-fasted diaphragms could be observed. A 24-hr. fast did not alter the uptake of galactose either.

The diaphragm of the rat fasted for 96 hr. weighs slightly less than that of the non-fasted animal. This could lead to a greater uptake per unit weight of an inert, freely diffusible substance. The measured uptake of each diaphragm was therefore subtracted from the theoretical maximum uptake by diffusion alone calculated from the expression

$$2 \times 0{\cdot}9 \times \frac{K}{V + 0{\cdot}9 \times P}$$ (ref. 6)

where K is sugar concentration in mgm./ml., V is volume of incubation fluid in ml. and P is weight of diaphragm in mgm.; it is assumed that the extracellular fluid (10 per cent of total weight) reaches an equilibrium with the buffer during the washing period. The difference between the fasted and non-fasted diaphragms was still found to be of the same order ($t = 2{\cdot}83$); the increased uptake could thus not be a result of decreased weight.

It is generally considered that galactose is not metabolized in the muscle[7] to any considerable extent, though Nakada and Wick have shown that some oxidation probably occurs in the rat diaphragm[8]. The uptake of galactose by the rat diaphragm evidently must depend mostly on the permeability of the muscle cell membrane to this sugar. It is noteworthy, however, that in three 'fasted' diaphragms the measured uptake was actually somewhat higher than the theoretical maximum uptake by diffusion.

The apparent change in the uptake of galactose by the fasted muscle could be brought about by the

following factors: (*a*) a true change in the permeability of the muscle cell membrane to galactose due to physical and/or chemical changes in the membrane environment during fasting (*p*H, ionic composition, hormonal influences, etc.); (*b*) a change in the equilibrium state of the sugar-carrier system[9] of the membrane as a result of changed intracellular free glucose concentration; (*c*) (increased ?) utilization of galactose; and (*d*) an artefact due to the inadequacy of reduction methods[10] for sugar determination.

No conclusive evidence of any one of these factors operating in the fasted state has been obtained; a detailed report of the experiments and their results together with an analysis will be published in another connexion.

Jeddi Hasan

Physiological Department,
Institute of Occupational Health,
Helsinki.
Jan. 26.

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Inhibition by Thyroxine of Enzymes requiring Pyridoxal-5-Phosphate

Since vitamin B_6 is beneficial to rats treated with thyroxine[1], the activity of some enzymes known to require pyridoxal-5-phosphate has been determined in the liver of rats treated with thyroxine.

The rats received 10 μgm. of DL-thyroxine (B.D.H.), during fifteen days. The activity of cysteine disulphhydrase, serine and threonine dehydrases, alanine–glutamic and aspartic–glutamic transaminases was measured in the liver homogenates (technique of Tonhazy *et al.*[2]).

It was found that cysteine disulphhydrase activity disappeared from the livers of the treated rats, and serine and threonine dehydrases and alanine–glutamic transaminase activity were reduced by 40 per cent as compared with normal values. Aspartic–glutamic transaminase showed little change. By *in vitro* addition of 0·05 micromole of pyridoxal-5-phosphate to the enzyme preparations, these inhibitions were reversed to the normal level. Likewise, these inhibitions did not appear if, simultaneously with thyroxine, pyridoxine-hydrochloride was administered to the animals, 5 mgm./rat/day, during 15 days.

Table 1. Activity of Serine Dehydrase
Determinations at 10, 30 and 60 min. expressed as micromoles of pyruvate formed per gram of dry weight liver (*in vitro* additions)

	Enzyme alone	Enzyme 0·05 m*M* pyr.-5-phos.	Enzyme 0·025 m*M* thyroxine	Enzyme 0·025 m*M* thyroxine 0·05 m*M* pyr.-5-phos.
10 min.	33	60	16	53
30 min.	66	165	33	132
60 min.	90	263	39·6	224

In vitro addition of 0·025 micromole of DL-thyroxine at *p*H 7·4 to normal liver homogenates produced similar inhibitions, though of lesser degree, to those found in the animal treated with thyroxine. This *in vitro* inhibition was also completely reversed by addition of 0·05 micromole of pyridoxal-5-phosphate.

This interrelationship between a hormone and a coenzyme is being studied further. However, in the light of Snell's theory of the formation of a Schiff base between an amino-acid and pyridoxal-5-phosphate, it seems that these inhibitions mean more than just a higher nutritional requirement of the vitamin in the hyperthyroid state. It could be part of the mechanism of action of the hormone.

Antonio Horvath

Institute of Physiology,
Santiago, Chile.
Jan. 29.

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Actively Acquired Tolerance to Tuberculo-Protein

Animals confronted in fœtal life, or shortly after birth, with antigenic substances may fail to develop an antibody response to such antigens in adult life. This inhibition of antibody response, termed 'actively acquired tolerance', is antigenically highly specific, and has been demonstrated with several unrelated antigens[1].

The possibility of rendering animals incapable of specific antibody responses by fœtal inoculation suggests a new approach to the study of acquired immunity to infectious disease. It is often difficult to assess the significance of a particular antibody response to immunity because several responses may be elicited simultaneously by the different antigens of the infecting micro-organism. Such an assessment might be possible, however, by comparing animals capable of a response to a specific antigen with animals rendered immunologically tolerant to it. In connexion with a study of the role of delayed-type hypersensitivity to tuberculo-protein (tuberculin sensitivity) in immunity to tuberculosis, we attempted to eliminate tuberculin sensitivity in the guinea pig by injecting the fœtuses with tuberculo-protein and whole tubercle bacilli.

Pregnant guinea pigs were subjected to laparotomy and the fœtuses injected through the uterine wall with one of the following substances: 1 mgm. (100 tuberculin units) of Old Tuberculin; 1 mgm., wet weight, tubercle bacilli of the attenuated B.C.G. strain, killed by heating at 70° C. for 10 min.; or 0·5 mgm., wet weight, living B.C.G. The volume of the inocula was 0·1 ml. The time of injection varied from one to forty-six days before birth.

Of 250 guinea pigs operated on, less than 5 per cent died as a result of the operation, and more than half delivered living young. When the young had reached a weight of 250 gm., they were tested for tuberculin sensitivity by the intradermal injection of 0·2 ml. of a 1 : 10 dilution of Old Tuberculin (2,000 tuberculin units). Skin reactions were observed over a period of 72 hr. The reactions were considered positive if the area of induration exceeded 6 mm. in diameter. After the initial tuberculin test, the animals were vaccinated intraperitoneally with either 200γ or 800γ, dry weight, of phenol-killed tubercle

Table 1. TUBERCULIN REACTION OF GUINEA PIGS AFTER EXPOSURE TO OLD TUBERCULIN AND WHOLE TUBERCLE BACILLI *in utero*, AND AFTER POST-NATAL VACCINATION WITH PHENOL-KILLED AND LIVING B.C.G.

Substance injected *in utero*	No. of fœtuses injected	No. of animals tuberculin-sensitive before postnatal vaccination	Tuberculin sensitivity after post-natal vaccination with:					
			200γ phenolized B.C.G.		800γ phenolized B.C.G.		Living B.C.G.	
			No. of animals					
			Positive	Negative	Positive	Negative	Positive	Negative
Old Tuberculin, 1 mgm.	19	0	6	13	—	—	13	0
Old Tuberculin, 1 mgm.	39	0	—	—	18	21	21	0
Heat-killed B.C.G., 1 mgm. (wet weight)	12	6	2	4	—	—	4	0
Living B.C.G., 0·5 mgm. (wet weight)	16	14	2	0	—	—	—	—
Control animals, not injected *in utero*	12		12	0	—	—	—	—

bacilli of the B.C.G. strain. A control group of twelve animals, not injected *in utero*, was vaccinated with 200γ phenol-killed B.C.G. A test for tuberculin sensitivity was carried out five weeks after vaccination. Animals not sensitized by postnatal vaccination with killed B.C.G. were re-vaccinated eight weeks later with a suspension of living B.C.G. containing 0·12 mgm., wet weight, of bacilli, and again tested with tuberculin five weeks later. The results obtained with the first group of animals on which tuberculin testing has been completed are summarized in Table 1.

None of the animals was sensitized to tuberculin by fœtal injection of Old Tuberculin. This is not surprising, as Old Tuberculin does not render normal, adult animals tuberculin sensitive[2]. Of nineteen animals injected *in utero* with Old Tuberculin, thirteen failed to show tuberculin sensitivity following post-natal vaccination with 200γ phenolized bacilli. That this vaccination was an adequate antigenic stimulus was evidenced by the fact that all the twelve control animals were sensitized. When guinea pigs injected *in utero* with Old Tuberculin were vaccinated after birth with 800γ phenolized bacilli, twenty-one of thirty-nine animals failed to become hypersensitive.

In contrast, fœtal injection with heat-killed tubercle bacilli sensitized six of twelve animals, and conferred tolerance on four of the non-sensitized ones. Fœtal injection with living B.C.G. sensitized fourteen of sixteen animals and conferred tolerance on none. Most of these animals were injected 27–43 days before birth, the gestation period of our guinea pigs being 66–71 days. It seems unlikely, therefore, that the animals were sensitized because they were already immunologically mature at the time of exposure to the antigen. It is possible, however, that the tubercle bacilli persisted in the fœtuses until they became immunologically mature. Several animals which were injected *in utero* with living or heat-killed B.C.G. were killed after birth, and acid-fast bacilli were, indeed, found in their tissues. It is of interest that living tubercle bacilli did not induce a degree of immunological tolerance when this could be done with Old Tuberculin.

The degree of actively acquired tolerance obtained in these experiments was significant but limited. It prevented the development of tuberculin sensitivity after vaccination with quantities of phenolized tubercle bacilli sufficient to bestow on normal guinea pigs a high degree of protective immunity against tuberculous infection (unpublished work). Subsequent vaccination with living B.C.G., however, rendered all the animals sensitive to tuberculin. Studies are in progress to enhance further the degree of tolerance to tuberculo-protein which can be bestowed on guinea pigs.

DAVID W. WEISS*
(The late) A. Q. WELLS†
Sir William Dunn School of Pathology,
University of Oxford.

* Merck Senior Postdoctoral Fellow, U.S. National Academy of Sciences.

† Died Oct. 9, 1956.

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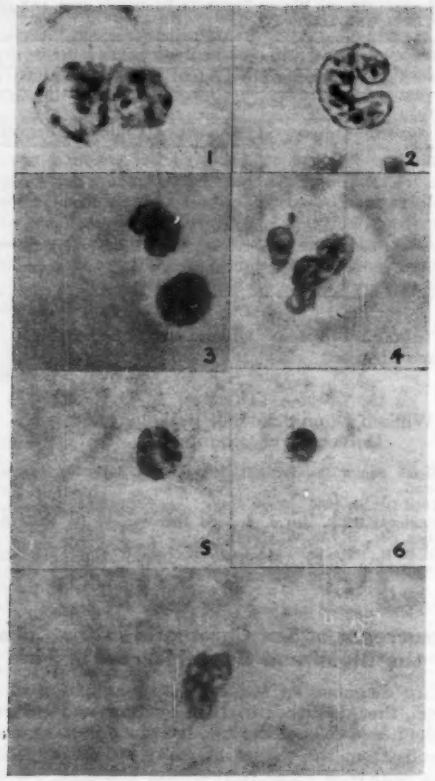
Occurrence of Sex Chromatin in the Cells of the Blood and Bone Marrow in Man

THE diagnosis of sex by the examination of cell nuclei, first described in 1949 by Barr and Bertram[1] in the nerve cells of the cat, has since been extended to cells from the tissues of many species, especially man, and is of great clinical and academic interest, particularly in individuals with disorders of sexual development. Davidson and Smith[2] extended these observations by their finding of a morphological sex difference in the mature polymorphonuclear granulocytes of the human subject; these cells show a drumstick-like process which is present in 1–7 per cent of the nuclei in the female, but in less than 1 per cent in the male.

These findings have been confirmed by other workers[3–5] and in a small unpublished series of thirty cases in this laboratory; the only reported exceptions have been two cases of Klinefelter's syndrome (testicular agenesis) in which, although the cells of skin sections showed the female type of nuclear pattern, drumsticks in the granulocytes were found less often than in normal females, although rather more frequently than in normal males[6]. This drumstick or nuclear satellite has been regarded[7] as the equivalent in the granulocyte of the heterochromatin mass seen at the nuclear membrane of resting cells from other tissues—this despite the unusual situation of these bodies and the disparity in size between the satellites and the usual heterochromatin body. The present investigation was undertaken to determine whether the satellite body is identical with the mass of heterochromatin seen in other cells or whether it is a sex characteristic morphologically unrelated to the *XX* complex.

Specimens of blood or bone marrow were obtained from ten individuals: five were male, four female and one, whose case will be described fully elsewhere, was a case of Klinefelter's syndrome showing the female type of nuclear pattern. Films were made of



(1) A pair of myelocytes showing, at opposite poles, heterochromatin masses adjacent to the nuclear membrane.
(2) A metamyelocyte showing, at the lower pole, a mass of heterochromatin at the nuclear membrane.
(3) A neutrophilic band cell showing a mass of heterochromatin at the nuclear membrane and a lymphocyte in which no such mass can be identified.
(4) A mature polymorphonuclear leucocyte showing a 'drumstick' attached to one lobe of the nucleus and, in the same lobe, a mass of heterochromatin in the nuclear membrane.
(5) An intermediate normoblast showing a heterochromatin mass on one side of the cell; there are other irregular condensations of chromatin in this cell, two of which are near the nuclear membrane but are distinguished by their rounded outline.
(6) A late normoblast which shows the homogeneous pyknotic nucleus in which heterochromatin cannot be identified.
(Bottom) A lymphocyte showing a heterochromatin mass on the nuclear membrane.
All figures, Feulgen stain, × 1,200

the specimens and were fixed, while still wet, in an alcohol–ether mixture; they were then stained by the Feulgen technique. The 'nuclear' sex of all the cases was assessed by examination of the granulocytes for satellite bodies and, in three of the cases, by examination of smears from the buccal mucosa; the remaining seven cases had confirmed their sex by their reproductive activities. In the case of the five males, a heterochromatin mass was identified at the nuclear membrane in 2·1, 5·5, 2·6, 0·0 and 3·0 per cent of the cells examined: in the five individuals with female-type nuclei a heterochromatin mass was identified in 46, 37·6, 18, 21·6 and 17·3 per cent of the cells examined. In each case at least 250 cells were examined, and cells which were crushed or distorted were excluded together with late normoblasts which have a dense pyknotic nucleus (Figs. 1–5, 7).

The heterochromatin mass was seen in all types of nucleated blood cells with the exception of the late normoblasts (Fig. 6), in which the nuclear chromatin forms a dense pyknotic homogeneous mass, and the megakaryocytes in which the large amount of nuclear chromatin is arranged in irregular condensations. The satellite body seen in the polymorphonuclear granulocytes stained uniformly with the rest of the nucleus and did not show the dense staining of the heterochromatin masses. In one female case it was possible to examine twenty-five polymorphonuclear granulocytes which showed the drumstick satellite; six of these cells also showed a heterochromatin mass lying on the nuclear membrane. This proportion agreed with the proportion of such masses seen in the other cells of the bone marrow and in the cells of the buccal mucosa of the same individual.

These observations demonstrate that the heterochromatin mass seen on the nuclear membrane of cells from squamous epithelium and other somatic tissues can also be identified in the nucleated cells of the blood and bone marrow, and that the satellite body of Davidson and Smith[3] is not identical with the heterochromatin mass and must be regarded as a sex characteristic rather than as the *XX* complex.

David J. B. Ashley

Department of Pathology,
United Liverpool Hospitals
(David Lewis Northern Hospital),
Leeds Street,
Liverpool 3.
Feb. 5.

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The Diego (Di^a) Blood Group: Tests in some Pacific Peoples

The Diego blood group was first reported[1] in 1954, and was thought to be a 'private' blood group. It is considered to be absent from the blood of unmixed Caucasians, and afterwards has been shown to be present in varying percentages[2] (2 per cent to more than 50 per cent) in the blood of six South American Indian groups, peoples of mixed blood in Venezuela, Brazilian Indians, North American Indians (Chippewa), and Chinese and Japanese resident in Canada and Venezuela.

It has been suggested that the Diego blood antigen is an Asiatic or Mongoloid characteristic rather than Indian because of its presence in Chinese and Japanese blood.

The present surveys now reported were intended to ascertain if a Mongoloid or American Indian component carrying the Diego antigen could be detected in eastern Polynesians, and in some peoples of the Australasian area of the Pacific. The study is incomplete. We acknowledge with gratitude the initial anti-Diego serum sample from Dr. Bruce Chown, of Winnipeg, Canada, and subsequent generous samples from Dr. Miguel Layrisse, of Caracas, Venezuela. The activity of both lots of serum was satisfactory by the indirect Coombs test on Di(a+) blood sent from Caracas.

The results of the present surveys on the Diego antigen are given in Table 1.

Table 1

Population tested	In association with	Di(a+)
Polynesians, Eastern	Mr. Thor Heyerdahl and Dr. Emil Gjessing	0/80
Australian aborigines, Central Australia	Prof. J. B. Cleland and Mr. J. R. Casley-Smith	0/112
Australian aborigines, Cape York	Dr. D. C. Gajdusek	0/50
Papuans, Eastern	Dr. D. C. Gajdusek	0/23
New Britain natives	Dr. D. C. Gajdusek	0/74

It will be seen that no evidence has been found to date of a Diego-positive racial component common to natives of the Australasian area and eastern Polynesia, and to American Indians and Mongoloids who possess such a component.

The complete results of these blood genetic surveys will be published at a later date.

Since writing this letter, we have seen the report by Lewis, Chown and Kaita[3], who found no evidence of the Di[a] antigen in 156 Eskimos from Hudson Bay, Baffinland and Labrador. Its presence in American Indians and Mongoloids, and its apparent absence in Eskimos and Polynesians, may prove to be a pointer of great anthropological significance.

R. T. SIMMONS

Commonwealth Serum Laboratories,
Parkville, N.2,
Victoria, Australia.
Jan. 29.

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Interaction of Heat and X-Rays in killing a Chalcid

THE modifying effects of temperature on various kinds of radiation injury has attracted considerable interest, and experiments have included studies with ultra-violet light on *Paramecium*[1], and with X-rays on human skin[2], eggs of *Ascaris*[3] and *Paramecium*[4]. In recent studies[5] of tolerance to X-rays and to heat in the chalcid, *Dahlbominus fuscipennis* (Zett.), killing by these two agents was found to be similar in a number of respects; thus, there is reason to believe that at least a part of the mechanism of killing by heat and by X-rays may be the same for both agents. This communication describes some experiments on the interaction of heat and X-rays in causing death in *D. fuscipennis*.

Adult females were reared on sawfly cocoons at controlled temperatures and humidities[6]. The age of all experimental groups was limited to 24–48 hr. after emergence; all experimental insects were starved. X-ray doses of approximately 10,000 r./min. were obtained at 12 cm. from the target of a 2-MeV. General Electric X-ray machine operating at 1·5 m.amp. Direct measurements of cumulative dosages were taken with a parallel-plate ionization chamber designed in this laboratory[7].

In the initial tests, *Dahlbominus* females were exposed to 200,000 r. in an exposure chamber surrounded by a water-jacket maintained at constant temperatures. The insects were held at different temperatures ranging from 10° to 35° C. immediately before, during or immediately after irradiation. For each temperature, the exposure consisted of a 15-min. warm-up (or cool-down) period, after which the insects were held at the selected temperature for 20 min. The X-ray dose of 200,000 r. was given over a 20-min. period. After exposure, the insects were returned to 23° C. for 24 hr., when mortality was assessed. Each experiment was repeated six times, totalling approximately four hundred insects for each of the different treatments.

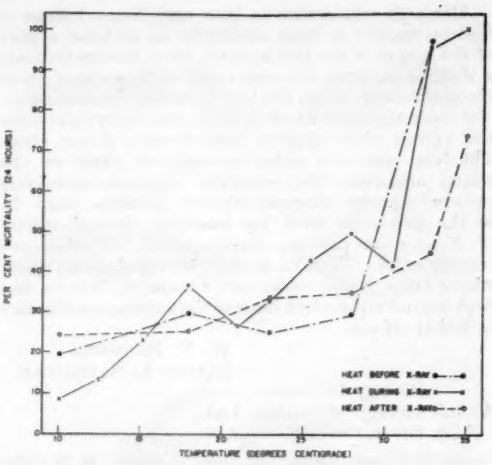

Fig. 1. 24-hr. mortality in *Dahlbominus* when held at different temperatures before, during and after exposure to 200,000 r. of X-rays. Each point represents an average result obtained from about 400 insects

The results (Fig. 1) show that less than 10 per cent died in groups held at 10° C. during irradiation. The kill increased gradually with increasing temperature (dose remaining constant), up to 30° C., from which point onward there was a sharp increase in killing to 100 per cent at 35° C. Mortality followed the same general course when the insects were held at the different temperatures after irradiation. However, when the heat experience occurred before the X-ray exposure, the sharp break at 30° was not evident, and mortality amounted to only 75 per cent at 35° C.

Further work was done at lower X-ray dosages to test the combined effects of heat and X-rays. Exposures to 160,000 r. of X-rays and 43° C. for 100 min. gave 24-hr. mortalities of 14 and 29 per cent respectively; accordingly, non-lethal half-doses (80,000 r. and 43° C. for 50 min.) were used to test the combined effects. When the heat was applied prior to the X-rays, the 24-hr. mortality amounted to 13·5 per cent (Table 1). Conversely, application of the heat after the X-rays resulted in a kill of 76 per cent. The difference between the two figures was highly significant ($P < 0{\cdot}001$).

Table 1. EFFECT OF THE SEQUENCE OF EXPOSURES TO HEAT AND X-RAYS

Treatment	Dead/total	24-hr. mortality (per cent)
50 min. at 43° C. + 80,000 r.	145/1,070	13·5
80,000 r. + 50 min. at 43° C.	717/976	76·4
Controls		
100 min. at 43° C.	175/1,205	14·5
160,000 r.	317/1,078	29·4

Although similarities in heat and X-ray killing in insects suggest a basic similarity in at least a part of the action of the two agents[5], these results indicate a difference, since the end result is dependent upon the sequence in which the two agents are administered. The mechanism by which heat so drastically influences the killing when applied after X-rays is not clear. The heat may act either through an effect on the whole organism (for example, through increasing metabolism), or alternatively its influence may be at the molecular level (for example, through effects of X-rays on protein, nucleic acids or other cell constituents). Thus, in an organism such as an insect where large X-ray doses are tolerated, X-rays and heat are not equivalent despite the striking similarities in lethal effects.

W. F. Baldwin
Claire A. Narraway

Biology Division,
Atomic Energy of Canada, Ltd.,
Chalk River, Ontario. Jan. 8.

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Skeletal Retention of Injected Radiophosphate in Chicks kept on Feeds of Different Phosphate Content

The use of radioactive tracers of elements necessary in animal nutrition has created new possibilities for studies of the metabolism of domestic animals. It is also important in the determination of their nutrient requirements. This communication describes some experiments in the phosphate metabolism of growing chicks.

In the first series, twenty-six pedigree hatched chickens were used. All had the same sire, a White Leghorn cock. Their dams were seven New Hampshire hens. After hatching, the chicks were wing-marked, weighed and transferred to six small cages which were electrically heated. All the chicks had the same feed, an all-mash ration containing 1·04 per cent calcium and 0·74 per cent phosphorus of dry matter. When the chicks were twenty-five days old, they were all injected intravenously with the same amount of phosphorus-32 (about 27 μc. as neutral orthophosphate in physiological sodium chloride solution). With regard to parentage and sex, the animals then were redistributed so that two cages contained males and four cages contained females. All through the experiment the chicks in half the cages had the same feed as before the injection. At first, the other chicks also were fed in this way, but beginning with the fourth day after the injection the calcium content in dry matter was raised to 1·57 per cent by adding calcium carbonate. At the same time, the phosphorus content was raised to 1·17 per cent of dry matter by adding monosodium phosphate.

The chicks were killed after a period of seven to twenty-seven days following the injections. Immediately after the chicks had been killed, both legs were cut off just above the tarsal joint. After the leg had been boiled in water for about two minutes, the metatarsal bone could easily be freed from adhering tissues.

Each bone was then dissolved by boiling with about 40 ml. 3 *M* hydrochloric acid in a 100-ml. Kjeldahl flask to which a simple condenser was attached. While still hot, the solution was filtered through a filter paper. The flask and the filter were washed three or four times with hot water and, after cooling, the volume was made up to 100 ml.

The radioactivity of the solutions was measured in a Geiger–Müller tube for liquids. 15·0 ml. was found to be most suitable and this amount was always used for the readings. The detector was connected to a counter with 'preset time'-setting. At least 15,000 impulses were always counted from each sample.

These first series gave the following results: (1) There was no significant difference in growth-rate for the two phosphate levels. (2) There was no definite tendency as to remaining radioactivity among the animals killed seven to twenty days after the injection. (3) In the bones from three male chicks which had been fed at the high-phosphate level and were killed twenty-four days after the injection, the activity was only about 70 per cent of that in the bones from two male chicks fed at the low-phosphate level and killed at the same time. (4) In the bones from three female chicks which had been fed at the high-phosphate level and were killed twenty-seven days after the injection the activity was nearly 80 per cent of that of the bones from two female chicks fed at the low-phosphate level and killed at the same time.

In a second series, fifteen chicks hatched from eggs from the same pen as the chicks in the first series were used. All these chicks thus had the same sire as the first ones and some of them even had the same dams. At first the treatment and the feeding were the same as in the first trial.

When the chicks were twenty-three days old, they were injected as described above with about 29 μc. phosphorus-32 each. They were then distributed in four cages. The sexes were not separated. During the first five days after the injections, the same feed as before was given. In two cages the chicks were then given a feed which contained 0·91 per cent calcium and 0·65 per cent phosphorus of dry matter, while the other ones had a feed with 1·6 per cent calcium and 1·18 per cent phosphorus of dry matter. Except for the differences in the quantities of calcium carbonate and monosodium phosphate, the feed in both cases was the same as that used in the first series.

The chicks were killed twenty-eight to thirty-two days after the injection. The metatarsal bones were taken out and the activities were measured in the same way as in the first series.

As in the first trial, there was no difference in growth between the animals at the two phosphate-levels. The average activity of the solutions from the animals at the high-phosphate level was only about 61 per cent of that of the solutions from the other chicks.

The average counts per minute were:

Low-phosphate level,			left	metatarsal	bone	1,601 ± 48
,,	,,	,,	right	,,	,,	1,610 ± 55
High-	,,	,,	left	,,	,,	953 ± 60
,,	,,	,,	right	,,	,,	968 ± 52

The differences between the activities are statistically significant ($P < 0·001$). It thus seems obvious that the retention of the phosphate once it is deposited in the bone tissues is affected to a rather large extent by the phosphate content of the feed.

It should be mentioned that experiments still going on at this Institute indicate that phosphate deposition in the bone tissues does not reach its maximum level until several days after the intravenous administration.

These experiments are being continued in order to obtain a better knowledge of the quantitative relations of the mineral metabolism and in order to make clear the general validity of these results.

S. A. Svensson

Institute of Animal Nutrition,
Royal Agricultural College,
Upsala 7. Jan. 29.

Bivalent Structure in *Periplaneta americana*

Diplotene and diakinesis are absent from the meiotic sequence of male *Periplaneta americana*[1]. In an analysis of this meiosis by the induction of these stages[2], we came to certain conclusions regarding bivalent structure which differ from those of Sharma, Parshad and Shegal[3]. We suggest that:

(1) While there are no visible chiasmata the evidence for their existence is cumulative, namely: (i) the formation of rod and ring bivalents; (ii) the regular formation of multiple ring and chain associations in interchange heterozygotes[4]; (iii) in an individual heterozygous for three independent interchanges, the number of arm associations in different nuclei is relatively constant although the degree and nature of the multiple association is variable (Table 1); (iv) the production of open-cross bivalents (Fig. *e*); (v) the occasional observation of bivalents associated interstitially (Fig. *e*); (vi) the persistence of association during the premetaphase stretch.

We are aware that individually some of these conditions can exist in the absence of chiasmata, but together they indicate chiasma formation. For example, terminal attraction is sufficient to withstand even the pre-stretch, and pairing is complete. What then determines the difference between rod and ring configurations if not terminalization of chiasmata? But chiasma formation is not the only factor responsible for the maintenance of association; matrical stickiness is also operative. It is probably for this reason that chiasmata cannot be resolved optically.

Table 1. Arm Association Frequency at Induced Diplotene–Diakinesis in a Karyotype 3*R*IV + 10.II + X
In compiling the table it has been assumed that ring IV multiples have four terminal arm associations, chain IV multiples three, ring bivalents two and rod bivalents one

Multiple association types	Bivalent type		Total arm associations per nucleus	No. of times observed
	Rings	Rods		
1*R*IV	9	5	27	1
1*R*IV + 1*C*IV	5	7	24	1
	6	6	25	1
	7	5	26	2
	8	4	27	2
	9	3	28	1
2*R*IV	5	7	25	1
	6	6	26	2
	7	5	27	1
	8	4	28	1
1*R*IV + 2*C*IV	6	4	26	1
2*R*IV + 1*C*IV	4	6	25	3
	5	5	26	6
	6	4	27	14
	7	3	28	8
	8	2	29	1
3*R*IV	6	4	28	1
	Total No. of cells analysed			47
	Mean arm association frequency			26·7

(*a*) Late zygotene: clear centromeric gap. (*b*) and (*c*) Pachytene: localized centromeric repulsion. (*d*) Late pachytene: extended centric loop. (*e*) Induced diplotene–diakinesis: one open cross bivalent (left) and one bivalent with a subterminal association (right)
All × 2,750; from acetic-alcohol/acetic-orcein squash preparations of testes pretreated with 0·05 per cent aqueous colchicine for approximately 4 hr.

(2) The opening out of bivalents is a consequence of repulsion, initially localized between homologous centromeres (Figs. *b* and *c*). This occurs in both treated and untreated material. As the centric loop extends during late pachytene, the distal regions remain associated when matrical stickiness is still operative (Fig. *d*).

Admittedly, this could be explained by assuming that chromosome reproduction proceeds from the centromere, but this would not satisfy the open-cross bivalents or those associated interstitially. They result when there is a lapse of matrical stickiness prior to complete terminalization. The 'ring-like' configurations which Sharma *et al.*[3] take as indicative of the absence of localized repulsion are, on the contrary, expected. Diakinesis bivalents are almost universally 'ring-like' when terminalization is complete in both arms. Is not the opening out of these bivalents partly due to centromeric repulsion?

(3) There is an appreciable difference in the morphology of the bivalents at late zygotene (Fig. *a*) and pro-metaphase due to: (i) a decrease in length; (ii) the development of a localized centric loop and its subsequent extension distally; and (iii) the assumption of a diffuse or lampbrush appearance prior to bivalent orientation.

K. R. Lewis

Botany Department,
Oxford.

B. John

Zoology Department,
Cardiff.

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Culture Conditions and Mutagenesis in *Drosophila melanogaster*

During the course of an investigation into the biochemical activity of formaldehyde in its relation to the mutation process in *Drosophila melanogaster*, a phenomenon has been observed which may be termed 'conditional anti-mutagenesis'.

Previously it has been shown that the admixture of formaldehyde in sublethal concentrations with the food of *Drosophila* larvæ produces a high frequency of sex-linked recessive lethal mutations[1]. It has been noted that formaldehyde and formic acid have similar metabolic fates in *in vitro* systems[2], and that the time at which formaldehyde is mutagenically effective appears to coincide with the time at which deoxyribonucleic acid is being synthesized[3]. This suggested to me the working hypothesis that formaldehyde is effective as a mutagen by competing with the normal (formic acid) metabolite in purine biosynthesis; the present communication describes an experiment illustrative of this hypothesis.

The culture medium used for the treatment of the larvæ throughout the investigation had the following composition:

Glucose	10 per cent
Dry, heat-killed brewer's yeast	10 ,, ,,
Agar	3 ,, ,,
Propionic acid	0·4 ,, ,,

This medium is referred to as the basic medium. When the temperature of the medium falls to 55° C. 25-c.c. portions are poured into four one-gill culture bottles, which are then stoppered with cotton-wool. Propionic acid is added when the basic medium temperature is 65° C., formaldehyde when the temperature is 60° C. Any further substances are added when the temperature of the basic medium is 75° C.; solids are first dissolved in distilled water, and the solution brought to the same temperature as the medium before addition. Four hours after preparation of the medium, fifty newly hatched Oregon-*K* larvæ (within an age variation of ± 3 hr.) are transferred to each of the treatment media, after which the cultures are placed in the constant-temperature room (25° C.), until the imagines emerge. Hatching males are removed before opportunity for mating can occur, and tested for sex-linked recessive lethals by the Muller-5 method. Each treated male is mated to two virgin Muller-5 females for three days (first brood), and afterwards removed to be mated to a further two virgin females for another three days (second brood). A second brood is usually sampled as a check against a possible change in brood pattern by influences on the speed of germ-cell development.

On the hypothesis stated above, it seems probable that the addition of preformed purine to the test-system would decrease the mutagenic activity of formaldehyde by 'by-passing' the system through which formaldehyde is assumed to act. This supposition forms the basis of an experiment in which formaldehyde and adenine (which is not itself mutagenic) are simultaneously administered to the test-system (Table 1). The addition of adenine is found to produce a significant depression of the mutagenic activity of formaldehyde in both broods: for several reasons, which cannot be discussed in detail here, this depression is not believed to be due to removal of free formaldehyde by chemical combination with the extra adenine present. Characteristically, it was observed that the treatment of larvæ with formaldehyde during the first day of larval life results in a

Table 1. Effect of Adenine on the Mutagenic Activity of Formaldehyde on the Basic Medium containing 10 per cent D.C.L. Brewer's Yeast

Type of treatment	Concentrations (per cent)	First brood				Second brood			
		n chrom.	*n* leth.	per cent leth.	χ^2	*n* chrom.	*n* leth.	per cent leth.	χ^2
Formaldehyde	0·128	1,286	125	9·72	57·5	660	32	4·85	10·9
Formaldehyde + adenine	*F*, 0·128 *A*, 0·09	2,018	68	3·37		1,198	25	2·09	

Table 2. Effect of Adenine on the Mutagenic Activity of Formaldehyde on the Basic Medium containing 10 per cent Anheuser-Busch Brewer's Yeast

Type of treatment	Concentrations (per cent)	First brood				Second brood			
		n chrom.	*n* leth.	per cent leth.	χ^2	*n* chrom.	*n* leth.	per cent leth.	χ^2
Formaldehyde	0·128	837	54	6·45	0·98	168	7	4·17	0·015
Formaldehyde + adenine	*F*, 0·128 *A*, 0·09	949	73	7·7		340	15	4·4	

Table 3. Effect of Adenine on the Mutagenic Activity of Formaldehyde on the Basic Medium containing 5 per cent Anheuser-Busch Brewer's Yeast

Type of treatment	Concentrations (per cent)	First brood				Second brood			
		n chrom.	*n* leth.	per cent leth.	χ^2	*n* chrom.	*n* leth.	per cent leth.	χ^2
Formaldehyde	0·128	901	73	8·1	17·9	236	12	5·08	3·49
Formaldehyde + adenine	*F*, 0·128 *A*, 0·09	1,767	70	3·96		331	7	2·11	

n chrom. = total number of chromosomes examined.
n leth. = number of sex-linked lethal mutations.
per cent leth. = percentage of sex-linked lethal mutations.
χ^2 = Chi-square test (significant at the 5 per cent probability-level when, for one degree of freedom, its value is greater than 3·84).

high mutation-rate in the first brood, followed by a steep drop from the first to the second brood[3]; if third or fourth broods are sampled, they do not differ significantly from the spontaneous mutation-rate.

While working at Pasadena, I carried out an experiment similar to the one described above as control to another experiment. Surprisingly, it was found that adenine had no effect on the mutagenic activity of formaldehyde, though the *Drosophila* stock was the same as that used in Edinburgh (Table 2). The only differing component in the two experiments was the strain of yeast used in the basic medium: in Edinburgh the yeast was Distillers' Co., Ltd. (D.C.L.), brewer's yeast, whereas in Pasadena it was the *K*2 strain of Anheuser–Busch brewer's yeast, the yeasts in both cases being dry and heat-killed.

In an attempt to analyse this difference of effect, an experiment was carried out in which the adenine concentration in the basic medium containing the Anheuser–Busch strain of yeast was doubled, on the assumption that the adenine concentration previously used might be insufficient to produce its effect with this particular strain. No anti-mutagenic effect, however, resulted in this case.

The possibility remained that the Anheuser–Busch yeast might contain a chemical component in greater amounts than the D.C.L. strain, which might thus be masking the anti-mutagenic effect previously produced by adenine. To test this possibility, an experiment was carried out using the Anheuser–Busch strain, but halving its concentration. As seen from Table 3, the antimutagenic effect of adenine towards formaldehyde returns, although the results are statistically significant only in the first brood.

This phenomenon, where the effectiveness of an anti-mutagen is conditional upon the strain (and concentration) of yeast employed, under what may otherwise be considered as standard cultural conditions, is clearly of importance in chemical mutation studies.

A detailed analysis of this and related phenomena is being published later. This work was carried out at the Institute of Animal Genetics, West Mains Road, Edinburgh 9, and while Gosney Research Fellow at the California Institute of Technology, Pasadena, California.

THOMAS ALDERSON

Institute of Animal Genetics,
West Mains Road,
Edinburgh 9.
Feb. 4.

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Selection of a Strain of *Plasmodium berghei* highly resistant to Chloroquine ('Resochin')

IN the past, numerous attempts to select strains of different plasmodia resistant to 4-aminoquinoline have been unsuccessful[1]. Recently, a successful attempt was recorded for *Plasmodium gallinaceum*, in which the resistance to chloroquine was found to be two-fold[2]. We have now succeeded in selecting a strain of mammalian plasmodium which is 200 times as tolerant to chloroquine as the parent strain.

The experimental selection of the strain was made in albino mice, the serial passages being exposed to progressively increasing doses of 'Resochin' solution administered intraperitoneally. The experiment involved 33 mouse passages during a period of about seven months. When the dose of drug administered reached 75 mgm./kgm. body-weight of the mouse, it was found to be lethal to the mice, but the parasites in them were tolerant to it.

The degree of resistance was tested by standard methods and was found to be 200-fold. The parent strain in infected mice, treated orally with 5 mgm./kgm. body-weight twice daily for three consecutive days, disappeared from the peripheral blood for at least three consecutive days after the treatment. For a similar effect, mice infected with the resistant strain had to be treated orally with 1,000 mgm./kgm. twice daily for three days. The selection of the strain to higher doses of the drug could not be pursued as the dose proved to be lethal to the host.

Whether this successful selection of a strain of *P. berghei* in mice 200 times as tolerant to chloroquine as compared to the parent strain is attributable to the difference in physiology of the parasite from that of others, or to the difference in the pharmacology of the drug in mice from that in other animals, is not known.

The experimental details and discussion of the results are being published in the *Indian Journal of Malariology*.

S. P. RAMAKRISHNAN
SATYA PRAKASH
D. S. CHOUDHURY

Malaria Institute of India,
Delhi.
Jan. 27.

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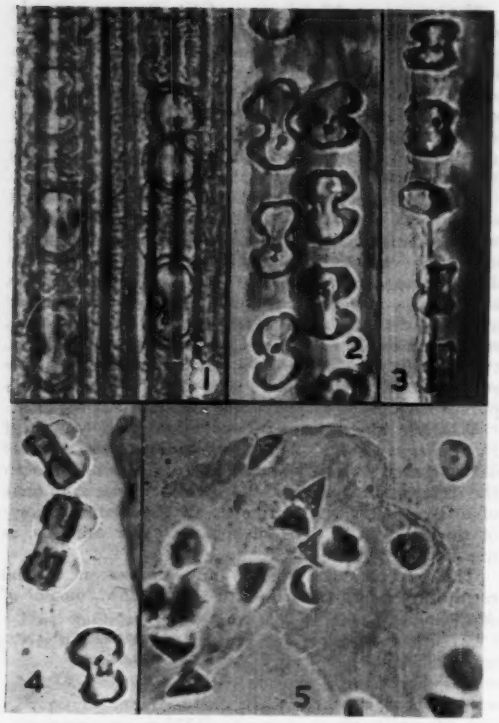
Detection of Opaline Silica in Grass Leaves

ONE of us[1] recently correlated the sizes and shapes of opaline silica particles in a pasture soil with those of silica bodies in the dominant grass. Finding that information in botanical literature is inadequate for making such correlations, we are investigating the opaline bodies of British grasses. In work on the leaf blades, we find that, unless appropriate techniques are employed, two main errors may arise: (1) the presence of opaline bodies are overlooked, or (2) if found, their shapes may be misinterpreted.

(1) For example, when using methods involving the separation of the upper and lower epidermis, we found ornamented rods in the leaf of *Agrostis tenuis* but could detect none in *Cynosurus cristatus*; yet, after treating with dilute chromic acid and mounting in canada balsam, the rods were equally conspicuous in both species. Once their presence in *C. cristatus* was known to us, we rendered the cellulose less prominent by immersing in a liquid of refractive index 1·50, after which some rods of opal could be seen on careful inspection.

(2) In *Sieglingia decumbens*, dumb-bell-shaped silica cells are visible at once in the separated epidermis (Fig. 1), but dilute chromic acid renders



Figs. 1–5. Opaline bodies in grass leaves. (× 700 approx.)

them much more conspicuous. If the chromic acid attack is brief, the opaline bodies remain *in situ* and still appear as dumb-bells, but with prolonged treatment they become displaced and the impression that each consists of a linkage of two spheres is seen to be incorrect (Figs. 2–4). When *Festuca ovina* is similarly treated, the small round silica cells yield conical, not spherical, bodies (Fig. 5).

In this work, Prat's method[2] of obtaining epidermal preparations of the leaf blades by scraping and peeling was satisfactory for some species. For others, especially those with heavily ribbed upper surfaces, a preliminary softening with potassium hydroxide and hydrochloric acid (based on the technique used by Priestley and Scott[3] for *Buxus* leaves) was necessary to obtain preparations of suitable size and quality. Several were prepared of each species, some to be double stained with methylene blue and ruthenium red, dehydrated and mounted in canada balsam, others to be treated with chromic acid. The latter treatment may be applied either to a separated epidermis or to the whole thickness of the leaf. Preliminary warming with hydrogen peroxide before floating on warm dilute chromic acid helps to prevent blackening. When the acid has made the specimen transparent, cold water is added and the specimen picked up on a cover-glass coated with a film of 'tacky' canada balsam, produced by the evaporation of a dilute solution in benzol. After washing and drying, the cover-glass is lowered on to a slide coated with warm balsam. In such a preparation only the opal appears distinct under an ordinary microscope, but with phase-contrast or crossed polars other detail is made clear.

It is intended to publish fuller details of these methods and of results which have bearing on grass phylogeny and pedogenesis respectively.

D. Wynn Parry
Frank Smithson

School of Agriculture,
University College of North Wales,
Bangor.
Jan. 11.

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Electric Strength of Unsaturated Hydrocarbon Gases

We have recently shown[1] that the electric strength of the alkanes and cyclic saturated hydrocarbons can be related in a relatively simple manner to the total cross-section, θ (largely elastic), for electron scattering. The results further indicated that this cross-section was composed of separate and additive cross-sections, θ_{C-H} and θ_{C-C}, for the electrons associated with the carbon–hydrogen and carbon–carbon bonds, respectively. It was found that θ_{C-C} was essentially zero, owing presumably to shielding by the electrons of the carbon–hydrogen bonds.

We have extended our measurements to hydrocarbons containing double bonds and present here a preliminary report of the results. Experimental techniques were the same as those described previously[1].

A plot of the quantity $B/\varepsilon_i^{3/n}$ against the number of carbon–hydrogen bonds per molecule, n_{C-H}, is shown in Fig. 1 for the alkanes and olefins. Here B is a constant appearing in the relationship between the first Townsend coefficient, α, the field, E, and the pressure[2], P:

$$\alpha/P = A\,(E/P)\exp(-BP/E) \qquad (1)$$

ε_i is the first ionization potential. As shown earlier[1],

$$B/\varepsilon_i^{3/n} = K'\theta \qquad (2)$$

where K', while not necessarily a constant, was found to be so for the saturated hydrocarbons.

Assuming that for the olefins θ may be written as a sum of cross-sections of individual bonds, we have:

$$\theta = n_{C-H}\,\theta_{C-H} + n_{C-C}\,\theta_{C-C} + n_{C=C}\,\theta_{C=C} \qquad (3)$$

where $n_{C=C}$ and $\theta_{C=C}$ refer to the number per molecule and the cross-section, respectively, of the double bonds. If θ_{C-C} is zero for the olefins, as it is for the alkanes, then Fig. 1 shows that K' is not only a constant for the olefins, but also has the same value as it has for the saturated hydrocarbons. Thus in both series of molecules, the addition of a CH_2 group produces a constant increment in the cross-section.

From the intercept of the curve for the olefins, it is clear that $\theta_{C=C}$ is not zero, and that the double bond ($n_{C=C}$ is unity in this series) contributes substantially to the scattering cross-section. This may be attributed (1) to a decrease in the shielding effect of the C–H bonds, since two of these are eliminated in the formation of the C=C bond, and (2) to the larger spatial configuration of the π-electron orbitals associated with the C=C bond.

The results shown in Fig. 1 include those for *n*-butene 1, *n*-butene 2, *iso*butene, *n*-pentene 1 and 2, methyl butene 2. There is, therefore, little dependence

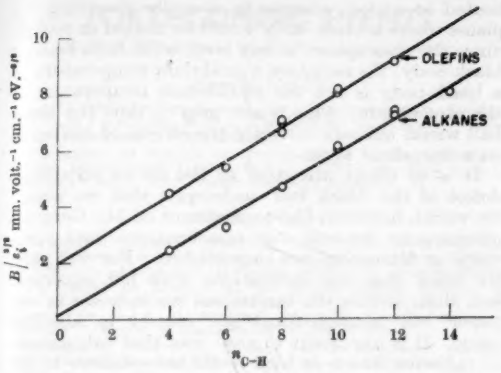

Fig. 1

of the cross-section on branching or position of the double bond.

From these results it might be expected that orbital 'smearing' due to resonance effects in compounds containing more than one double bond would lead to an increased contribution to the cross-section of each double bond. Using a value of $\theta_{C=C}$ for the cross-section of the C=C bond obtained from the intercept in Fig. 1, and assuming that K' is a constant for all molecules considered, values of $n_{C=C}$ are calculated for butadiene and benzene from the measured values of $B/\varepsilon_i^{1/2}$. Values obtained were: butadiene, $n_{C=C} = 2{\cdot}8$; benzene, $n_{C=C} = 3{\cdot}6$.

Conjugation does, therefore, increase the effective cross-section of each double bond.

A more complete report of this work will be published elsewhere.

R. W. Crowe
J. C. Devins

General Electric Research Laboratory,
Schenectady, N.Y.
Jan. 28.

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[2] Crowe, R. W., Bragg, J. K., and Devins, J. C., *J. App. Phys.*, **26**, 1121 (1955).

Relativity and Space Travel

The interesting exchange between Profs. H. Dingle and W. H. McCrea[1] on the subject of relativity and space flight has now produced a minor ripple in the United States[2]. Whether this is a precursor of a new controversy or just a highly attenuated wave, only future observations will show.

I wish to comment briefly and suggest an experimental approach. Let me first state that I concur with Prof. McCrea's view. A basic problem, as I see it, is whether there exists symmetry between observer *A* who stays on the Earth and observer *B* who travels out and then returns. This symmetry does not exist (contrary to Prof. Dingle's statement) since *B* experiences forces while *A* does not, so that there is no *a priori* reason to expect them to be of the same age when they meet again. In fact, the problem has been treated adequately in Tolman's book[3]. There appears to be no paradox and no controversy. A similar lack of symmetry exists in the case of an artificial satellite. Observer *A* on the Earth sees the artificial satellite circling around the Earth, while observer *B* in the satellite, from his point of view, can see observer *A* circling around. If the situation is really symmetrical, then observers *A* and *B*, comparing their clocks after a long time of operation, should find agreement. However, as has been shown[4,5], observer *B*'s clock will run more slowly. Clock *B* in a satellite in an orbit at very low altitude will lose time at a rate of 1 part in 3×10^9. This effect should be measurable using atomic beam clocks which have an inherent accuracy of 1 part in 10^{13}. I suggest using long accumulation times, counting ticks both for clock *A* and clock *B* and comparing after a large number of ticks[5]. (By operating the satellite at different altitudes, one can also verify the gravitational red shift which is superimposed on the effect discussed here.)

There should be no rush, however, for spaces on a satellite. In a lifespan of 100 years the satellite inhabitant would gain only 1 second; in view of other well-known hazards involved in space travel, I do not recommend this particular method for increasing one's life-span.

S. F. Singer

University of Maryland,
College Park, Maryland.
Jan. 3.

[1] *Nature*, **177**, 782 (1956); **178**, 680 (1956).
[2] *Sci. American*, **195**, No. 6, 58 (Dec. 1956). *Jet Propulsion* (J. Amer. Rocket Soc.), **26**, 1105 (1956).
[3] Tolman, R. C., "Relativity, Thermodynamics and Cosmology", 194 (Clarendon Press, Oxford, 1934).
[4] Winterberg, F., *Astronaut. Acta*, **2**, 25 (1956).
[5] Singer, S. F., *Phys. Rev.*, **104**, 11 (1956).

A Suggested Experiment on the 'Clock Paradox'

The discussion of the 'clock paradox' of relativity theory has recently been renewed, in articles by Dingle[1] and McCrea[2], in the form of the question whether a space traveller from the Earth whose velocity relative to the Earth over a considerable part of his journey was comparable with the velocity of light would find on his return that the duration of the journey was less by his clock than by one which had remained on the Earth.

This question can be settled by an experiment which is now technically feasible. Durbin, Loar and Havens[3] have described an experiment in which a closely parallel beam of charged π-mesons of energy 73 MeV. was projected into the laboratory from a cyclotron, and the decrease in the number of particles with distance investigated. This decrease was found to be about 1 per cent per 10 cm. of the straight-line flight, and results from the decay of the π-meson into a μ-meson and a neutrino. The mean life[4] of π-mesons at rest in the laboratory is $(2{\cdot}5_6 \pm 0{\cdot}1) \times 10^{-8}$ sec., while an energy of 73 MeV. corresponds to a velocity three-quarters that of light. These particles are therefore admirably fitted for the role of space travellers in miniature; a journey which one-half of a group would survive would be less by a factor about 10^{16} in distance as compared with an interstellar journey by rocket at the same speed.

In principle, the controversy between Dingle and McCrea can be settled, therefore, by deflecting the meson beam in the experiment of Durbin, Loar and Havens by one or more electromagnets so that it returns to intercept its own track, and measuring the proportion of particles returning.

In a fuller account which is being submitted for publication[5], I point out how the experiment can be

designed so that the technical difficulties are no greater than in experiments[3,4] which have already been made with π-mesons and show that the proportion of particles surviving a round journey of 800 cm. must be less than 0·36 if Dingle's views are correct, whereas the value to be expected on an orthodox interpretation of relativity theory is 0·41 and 0·47 for 73 MeV. and 100 MeV. particles respectively. The 'journey' suggested here is not the same as that proposed by Crawford[6], to which objections can be raised on the ground that the 'travellers' do not return to their starting point. Crawford does not seem to be aware that the experiment with π-mesons which he suggests has already been done.

In the fuller account, some considerations suggested by the proposed experiment will be examined, and an attempt made to show that Dingle's theory is not consistent with the principles of special relativity as they apply to unaccelerated motion in an inertial frame.

W. Cochran

Cavendish Laboratory,
Cambridge.
Jan. 12.

[1] Dingle, H., *Nature*, **177**, 782; **178**, 680 (1956).
[2] McCrea, W. H., *Nature*, **177**, 784; **178**, 681 (1956).
[3] Durbin, R. P., Loar, H. H., and Havens, W. W., *Phys. Rev.*, **88**, 179 (1952).
[4] Wiegand, C., *Phys. Rev.*, **83**, 10 (1951).
[5] Cochran, W., *Proc. Camb. Phil. Soc.* (in the press).
[6] Crawford, F. S., *Nature*, **179**, 36 (1957).

Experimental Determination of Atmospheric Infra-red Radiation

In a recent communication[1], Mr. J. L. Gergen gives a brief account of his 'black ball' radiometer, and in comparing measurements of atmospheric radiation so made with those described by us[2] states that they "are not in agreement". A fuller account of our work has now appeared[3] with more information than was available to him at the time of writing.

In the atmosphere, which for this purpose we consider to be plane and uniformly stratified, we may consider that at any height z there are two independent radiation streams: an upward stream U_z, and a downward stream D_z. In the atmosphere, the significant factor is whether the atmosphere is cooling or heating as a result of these streams, and a simple analysis would show that this is given by the (one-dimensional) divergence, $\frac{d}{dz}(U_z - D_z)$. This can best be determined by calculating or measuring the values of both U_z and D_z and then taking their differentials. Thus measurements of these quantities are, at the present state, the most useful kind of atmospheric radiation data.

It is unfortunate that Mr. Gergen's 'black ball' measures, in effect, U_z *plus* D_z, since the temperature T of the black ball is determined by the equivalent black-body temperature of the combined fluxes, that is to say $\left(\frac{U_z + D_z}{2\sigma}\right)^{1/4}$ (neglecting the spherical effects). Whether this is greater or less than the air temperature at the same place does not have great significance, and since it is very difficult to separate the contributions of U and D, it is not possible to calculate $U_z - D_z$ or the divergence. To put it another way, Mr. Gergen states that he is observing the places in the atmosphere where the air is being heated or cooled, whereas he is really observing the places where a black-body would be heated or cooled. Since the atmosphere at any level is far from being a black-body, the radiation equilibrium temperature of a black-body is not the equilibrium temperature of the atmosphere. Clouds are 'grey'; thus the black ball would indicate correctly the effects of radiation on a thin cloud layer.

It is to direct attention to the above important defect of the 'black ball' techniques that we write; we would, however, like to comment on Mr. Gergen's comparisons between our measurements and some made at Minnesota but unpublished. For our part, we think that our calibrations were not equivocal and that, within the limitations we indicate in our paper, our measurements are correct in absolute value. It is important to note, too, that calculations of radiation fluxes at high levels are sensitive to the accuracy of the humidity data available. For the measurements we have made at Farnborough, we had the advantage of the assistance of the Meteorological Research Flight; simultaneous measurements of air temperature and humidity were made. So far as we know, the Meteorological Research Flight remains the only organization which can measure the humidities found at high levels. We do not know what humidities were used at Minnesota, nor what corrections were made for variation of carbon dioxide path-lengths with height in their calculations.

A. W. Brewer

Clarendon Laboratory,
Parks Road,
Oxford.

J. T. Houghton

Royal Aircraft Establishment,
Ambarrow Court,
Nr. Camberley, Surrey.
Feb. 2.

[1] Gergen, J. L., *Nature*, **179**, 36 (1957).
[2] Houghton, J. T., and Brewer, A. W., Paper of Meteor. Res. Comm. No. 914 (London, 1955).
[3] Brewer, A. W., and Houghton, J. T., *Proc. Roy. Soc.*, A, **236**, 175 (1956).

The relations which indicate the manner in which the black ball temperature-differences are related to the radiative divergence will appear in a forthcoming paper in the *Journal of Meteorology*, and as shown there, the cooling rate is positive when the black ball difference is positive, and vice versa. The exact numerical relations are, however, still somewhat questionable and require further study.

I am happy to have received the more complete analysis of the work by Drs. Brewer and Houghton, and, of course, as they state, their experimental results also bear out the fact that the radiation chart requires revision. My comment on their previous work must not be regarded as a criticism of their experimental methods, which were most thorough and careful, but on the accuracy of the determination of upward or downward fluxes (or equivalently, the radiation temperatures) when measured with a spectrally selective device. Drs. Brewer and Houghton have made the first careful determination of atmospheric infra-red radiation and deserve all credit for having made a significant advance in the understanding of the heat balance for the Earth.

John L. Gergen

School of Physics,
University of Minnesota,
Minneapolis 14, Minnesota.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 13

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. D. P. J. Wood and Mr. B. J. Moser: "Cambridge Expedition to North Borneo".

UNIVERSITY OF LONDON (in the Chemistry Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. B. S. Haldane, F.R.S.: Karl Pearson Centenary Lecture.*

Tuesday, May 14

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (at the Royal College of Science, Imperial Institute Road, London, S.W.7), at 10.30 a.m.—Annual General Meeting, followed by Scientific Papers.

UNIVERSITY OF LONDON (at the Wright-Fleming Institute of Microbiology, St. Mary's Hospital Medical School, London, W.2), at 5 p.m.—Dr. B. A. D. Stocker: "Heritable Transformations of Bacteria"* (Second of four Almroth Wright Lectures).

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Dr. R. v. d. R. Woolley: "Large Telescopes" (James Forrest Lecture).

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the CHEMICAL ENGINEERING and PLASTICS AND POLYMER GROUPS, at 14 Belgrave Square, London, S.W.1), at 5.30 p.m.—Mr. L. H. Vaughan, Mr. B. T. Hayes and Mr. W. J. Read: "Some New Chemical and Physical Aspects of Polyester Resin Technology".

UNIVERSITY OF LONDON (at the Royal College of Science, London, S.W.7), at 5.30 p.m.—Prof. A. Salam: "Elementary Particles" (Inaugural Lecture).

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. W. A. Baker: "Reinforced Plastics for Primary Aircraft Structures".

Tuesday, May 14—Friday, May 17

INSTITUTION OF GAS ENGINEERS (at the Institution of Civil Engineers, Great George Street, London, S.W.1)—94th Annual General Meeting.

Wednesday, May 15

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Mortimer Wheeler: "Science in Archæology" (Trueman Wood Lecture).

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. G. Ramsay: "Moine-Lewisian Relations at Glenelg, Inverness-shire"; Dr. N. Rast: "Tectonics of the Schichallion Complex".

PHYSICAL SOCIETY, COLOUR GROUP and OPTICAL GROUP (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Mr. J. Guild: "Observations on the Behaviour of Diffraction Gratings" (Thomas Young Oration).

ROYAL SOCIETY OF MEDICINE, COMPARATIVE MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5 p.m.—Discussion Meeting on "Recent Advances in the Use of Tissue Culture Methods in Virus Research". Opening Speakers: Dr. F. Kingsley Sanders, Mr. R. F. Sellers and Mr. T. W. F. Pay.

ROYAL STATISTICAL SOCIETY (joint meeting with the ROYAL METEOROLOGICAL SOCIETY, at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Meeting on "Analysis of Geophysical Time Series". Mr. J. M. Craddock: "An Analysis of the Slower Temperature Variations at Kew Observatory by Means of Mutually Exclusive Band Pass Filters"; Mr. H. Charnock: "Notes on the Specification of Atmospheric Turbulence"; Dr. J. Neumann and Dr. S. Rushton: "Some Applications of Time Series Analysis to Atmospheric Turbulences and Oceanography".

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. H. E. Huxley and Dr. Jean Hanson: "Studies on the Mechanism of Muscular Contraction".

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Physics Lecture Theatre, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 6 p.m.—Mr. E. Halfpenny: "Tonal Evolution of Wood-wind Instruments".

ROYAL AERONAUTICAL SOCIETY, GRADUATES' AND STUDENTS' SECTION (at 4 Hamilton Place, London, W.1), at 7.30 p.m.—Mr. W. H. Stephens: "Guided Weapon Research and Development".

Thursday, May 16

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 4 p.m.—Annual General Meeting.

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. A. L. Hodgkin, F.R.S.: "Ionic Movements and Electrical Activity in Giant Nerve Fibres" (Croonian Lecture).

UNIVERSITY OF LONDON (at Birkbeck College, Malet Street, London, W.C.1), at 4.30 p.m.—Prof. L. Brillouin: "Information Theory in Pure Physics".* (Further lectures on May 20 and 22.)

LONDON MATHEMATICAL SOCIETY (at the Mathematical Institute, Elizabeth Street, Liverpool), at 5.15 p.m.—Prof. C. Ehresmann: "On Foliated Spaces".

CHADWICK TRUST (at the Royal Society of Health, 90 Buckingham Palace Road, London, S.W.1), at 5.30 p.m.—Mr. Herbert Addison: "The Conservation of Water Supplies"* (Chadwick Public Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 26 Portland Place, London, W.1), at 7.30 p.m.—Symposium on "The Laboratory Aspects of Amœbiasis".

UNIVERSITY OF LONDON (at Wye College, near Ashford, Kent), at 8.15 p.m.—Dr. N. D. Dijkstra (Agricultural Experiment Station, Hoorn): "The Conservation of Grass for Feeding Purposes in Agriculture".*

Thursday, May 16—Friday, May 17

ALUMINIUM DEVELOPMENT ASSOCIATION (at the Institution of Electrical Engineers, Victoria Embankment, London, W.C.2)—Symposium on "Aluminium in Electrical Engineering".

Friday, May 17

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5.15 p.m.—Mr. E. W. Pike: "Navigation and the Airlines".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Kathleen Kenyon: "Excavations at Jericho".

Saturday, May 18—Sunday, May 19

ASSOCIATION OF SCIENTIFIC WORKERS (at St. Pancras Town Hall, Euston Road, London, N.W.1), at 10.30 a.m. Saturday and 10 a.m. Sunday—Annual Conference.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEMONSTRATOR IN THE DEPARTMENT OF BOTANY—The Registrar, The University, Liverpool (May 15).

LECTURER IN PHYSICS—The Principal, Dudley and Staffordshire Technical College, Dudley (May 16).

HEAD (British) OF THE DEPARTMENT OF CHEMISTRY; and HEAD (British) OF THE DEPARTMENT OF BIOLOGY, in the Faculty of Science, National University of Libya, Tripoli—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1, quoting "Science, Libya" (May 17).

ASSISTANT LECTURER (with special qualifications in pure mathematics) IN MATHEMATICS—The Registrar, The University, Manchester 13 (May 18).

LECTURER IN EDUCATION—The Principal, Borough Road College, Isleworth, Middlesex (May 20).

SENIOR LECTURER or LECTURER IN INORGANIC CHEMISTRY at the University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (May 21).

ASSISTANT LECTURER or LECTURER IN APPLIED MATHEMATICS—The Registrar, University College, Singleton Park, Swansea (May 23).

PEDOLOGIST, Scientific Officer or Senior Scientific Officer grade (with a good honours degree in chemistry, physics, geology or mineralogy, with postgraduate research experience, preferably in soil science or related fields of study, for example, clay mineralogy and sedimentary petrology), to study the characteristics and development of Welsh mountain soils as a member of a Research Unit stationed at Bangor concerned with investigation into the influence of human settlement and intensity of land use and local climatic variation on the vegetation and soils of Snowdonia—The Establishment Officer, The Nature Conservancy, 19 Belgrave Square, London, S.W.1 (May 25).

SENIOR LECTURER IN MECHANICAL ENGINEERING at Singapore Polytechnic—The Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (May 25).

LECTURER or ASSISTANT LECTURER IN BOTANY—The Secretary, The University, Exeter (May 31).

MATHEMATICIAN or PHYSICIST to work on water movements and turbulence in lakes; and a PLANT PHYSIOLOGIST to work on fresh water algae at a laboratory on Windermere—The Director, Freshwater Biological Association, The Ferry House, via Ambleside, Westmorland (May 31).

LECTURER IN ZOOLOGY, to take responsibility for the teaching of entomology—The Secretary, The University, 38 North Bailey, Durham (June 1).

RESEARCH CHEMIST (with a university honours degree in science with chemistry as a major subject, or equivalent qualifications, and preferably with research experience in physical chemistry) AT THE IRRIGATION RESEARCH STATION, C.S.I.R.O., Merbein, Victoria, Australia, to carry out an investigation into the dipping, drying and processing of vine fruits with special reference to problems in diffusion kinetics involving the transfer of water through organic membranes including the waxy coating of the grape—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 490/62 (June 1).

RESEARCH DEMONSTRATOR IN BOTANY—The Registrar, University College, Singleton Park, Swansea (June 1).

SENIOR LECTURER (with a Doctorate of Philosophy or Science, awarded for research in theoretical physics) IN THEORETICAL PHYSICS at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 7).

ASSISTANT (preferably with an honours degree in science or agriculture) IN THE CHEMISTRY DEPARTMENT at Auchincruive, for work mainly relating to the analysis of soil and other agricultural materials—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (June 10).

LECTURER IN AERODYNAMICS—The Secretary of University Court, The University, Glasgow (June 12).

Chair of Human Physiology and Pharmacology in the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 15).

Lecturer or Assistant Lecturer in Biochemistry at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (June 20).

Demonstrators and/or Tutorial Students (3) in the Department of Geology—The Registrar, University College of North Staffordshire, Keele, Staffs (June 22).

Lecturer or Assistant Lecturer in Electronic Computing—The Registrar, The University, Leeds (June 30).

Assistant Lecturer (with a degree in microbiology, bacteriology, botany, biochemistry or cognate fields) in the Department of Microbiology—The Registrar (Room 9, O.R.B.), The University, Reading (July 1).

Assistant Lecturer (with special qualifications in physical or inorganic chemistry) in Chemistry—The Secretary, The Royal College of Science and Technology, Glasgow.

Director (preferably a physicist, with experience of research in fibre technology at a textile research institute in this country) of Jute Research (Technology) at the Jute Research Institute, near Dacca, East Pakistan—The Ministry of Labour and National Service (E.9), Almack House, King Street, London, S.W.1, quoting A.12/PAK/163/TCS.

Experimental Officers and Assistant Experimental Officers at the Radio Research Station (D.S.I.R.), Datchet, Bucks, to (*a*) assist in radio research, and (*b*) prepare abstracts of scientific and technical articles on radio research and development—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.111/7A.

Grade I Recordist in the Department of Applied Electroencephalography, Maida Vale Hospital—The Secretary, The National Hospitals for Nervous Diseases, Queen Square, London, W.C.1.

Head (with high academic qualifications in physics, and teaching, research, or industrial experience) of the Department of Physics; and Head (with high academic qualifications in mathematics, and teaching, research or industrial experience) of the Department of Mathematics—The Principal, Technical College, Queen Street South, Huddersfield.

Master to teach Physics throughout the school, including some sixth form work—The Headmaster, Oundle School, Oundle, Peterborough, Northants.

Physicist or Electrical Engineer (with a first- or second-class honours degree or equivalent in physics or electrical engineering, and at least three years postgraduate research experience) with the Ministry of Supply at the R.A.E., Bedford, for the design of precision electrical and electronic instruments for use in wind tunnel operation and for the measurement of physical quantities in wind tunnels—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.117/7A.

Professor of Chemistry—The Dean, College of Arts and Science, Baghdad, Iraq.

Radiation Physiologist (Ph.D. or equivalent qualifications, and interested in starting a programme of fundamental research on the physiological effects of radiation in small animals)—File 4B, Atomic Energy of Canada Limited, Chalk River, Ontario, Canada.

Research Assistants (2) (with an honours degree in chemistry) in the Physical Chemistry Laboratory, for work on problems connected with the interaction of amino-acids or nucleic acid components with sugars or with amino-acids—The Clerk to the Governors, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17.

Senior Lecturer (capable of developing courses in plastics and rubber technology) in High Polymer Technology—The Principal, Welsh College of Advanced Technology, Cardiff.

Soils Geologist (with a good honours degree in geology with two years postgraduate experience in soils geology or with some experience or inclination towards soils geology) with the Government of Sarawak to carry out regional geological mapping with the main purpose of demarcating different soil types—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/24/07.

Statistician (with a good honours degree in mathematics or statistics) in the Section of Statistics for biometrical research and consultation—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 57/9.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Air Ministry: Meteorological Office. Meteorological Reports, No. 17: Temperature-Compensated Equivalent Headwinds for Jet Aircraft. By A. F. Crossley. (M.O. 62 1a.) Pp. ii+10. (London: H.M. Stationery Office, 1956.) 1*s*. net. [203

University College of Wales, Aberystwyth. Welsh Plant Breeding Station. Bulletin Series H, No. 18: The Herbage Production of Two Strains of Perennial Ryegrass. By Roy Hughes. Pp. 78. 7*s*. 6*d*. Bibliography of Articles, Reports and Scientific Papers by Members of the Staff, 1919–1955. 1: Alphabetical List. 2: Chronological List. Compiled and edited by Irene D. Rees. Pp. ii+98. 7*s*. 6*d*. (Aberystwyth: Welsh Plant Breeding Station, University College of Wales, 1956.) [203

Planning, Vol. 23, No. 408: Salaries of Graduates in Industry. Pp. 45–68. (London: Political and Economic Planning, 1957.) 2*s*. 6*d*. [203

Health and Radiation. Part 2: The Cause of Cancer is Known. By Michael Ash. Pp. 44. (Enfield, Mddx.: ARO Research Team, 1957.) 5*s*. [203

London School of Hygiene and Tropical Medicine, incorporating the Ross Institute. Industrial Advisory Committee Bulletin No. 11: Iron-Deficiency Anaemia. By R. Ford Tredre. Pp. 24. (London: London School of Hygiene and Tropical Medicine, 1957.) [203

University of Cambridge: Department of Engineering. Report of the Head of the Department for the year 1955–56. Pp. 14. (Cambridge: The University, Department of Engineering, 1957.) [203

The Colombo Plan for Co-operative Economic Development in South and South-East Asia—Fifth Annual Report of the Consultative Committee. Pp. 155. (Cmnd. 50.) (London: H.M. Stationery Office, 1957.) 5*s*. 6*d*. net. [213

Linde Molecular Sieves for Selective Adsorption. Pp. 28. (Poole: British Drug Houses, Ltd., 1957.) [213

Proceedings of the University of Durham Philosophical Society. Vol. 12, No. 16: Submaritime Festucetum Rubrae on the Magnesian Limestone in County Durham. By D. A. Walker. Pp. 170–174. Vol. 12, No. 17: A Study of Cranefly Eggs (Diptera: Tipulidae) with particular reference to the Micropyle and the Terminal Filament. By D. M. Robinson. Pp. 175–182. Vol. 12, No. 18: The Role of Soil Fungi in the Spread of Orchid Species in Clay Pits. By J. A. Richardson. Pp. 183–189. (Durham: University of Durham Philosophical Society, 1956.) [213

The Poet's Way of Knowledge. By Prof. C. Day Lewis. (The Henry Sidgwick Memorial Lecture, 1956.) Pp. 32. (Cambridge: At the University Press, 1957.) 5*s*. net. [213

British Oxygen and the Monopolies Commission. Pp. 14. (London: The British Oxygen Co., Ltd., 1957.) [253

Abstracts of Dissertations approved for the Ph.D., M.Sc., and M.Litt. Degrees in the University of Cambridge during the Academical Year 1954–55. Pp. xviii+261. (Cambridge: Board of Research Studies, The University, 1957.) [253

The Registrar General's Quarterly Return for England and Wales. Births, Deaths and Marriages; Infectious Diseases; Weather; Population Estimates; quarter ended 31st December, 1956. Pp. 32. (London: H.M. Stationery Office, 1957.) 1*s*. 6*d*. net. [253

Other Countries

South Rhodesia. Geological Survey Bulletin No. 45: The Geology of the Odzi Gold Belt. By Dr. W. H. Swift. Pp. iv+44+6 plates. Southern Rhodesia Geological Survey. Mineral Resources Series No. 14: Manganese. Pp. 5. (Salisbury: Government Printer, 1956.) [203

University of Helsinki: Institute of Meteorology. Papers, No. 77: Some Aspects of Fog, with special reference to South Finland. By Aili Nurminen. Pp. 80. (Helsinki: University of Helsinki, Institute of Meteorology, 1956.) [203

City of Launceston. Annual Report of the Director of the Queen Victoria Museum and Art Gallery, 1955–1956. Pp. 8. (Launceston: Queen Victoria Museum and Art Gallery, 1957.) [203

Texas Instruments Incorporated. Annual Report, 1956. Pp. 20. (Dallas, Texas: Texas Instruments, Inc., 1957.) [203

Bulletin of the Florida State Museum, Biological Sciences. Vol. 1, No. 5: Life History Studies of some Florida Insects of the Genus *Archipsocus* (Psocoptera). By Edward L. Mockford. Pp. 253–274. 35 cents. Vol. 2, No. 1: Range Extensions of Western North Atlantic Fishes, with Notes on some Soles of the Genus *Gymnachirus*. By David K. Caldwell and John C. Briggs. Pp. 12. 25 cents. (Gainesville, Fla.: Florida State Museum, 1957.) [203

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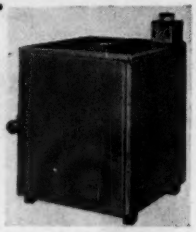

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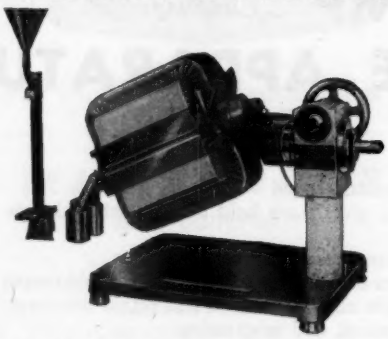

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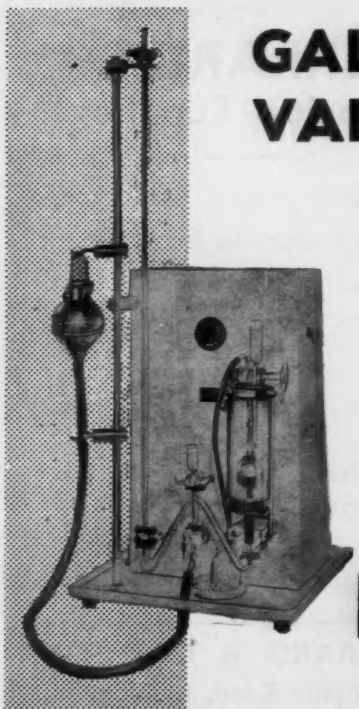

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